FPM

1981-82 MICHIGAN FOREST PEST REPORT

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Edited by

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Annual Report 1981 and 1982

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SUMMARY OF PEST CONDITIONS

UPPER PENINSULA

UPPER PENINSULA

Robert Heyd
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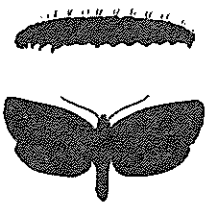
Marquette

INSECTS

SPRUCE BUDWORM
(*Choristoneura fumiferana*)



1981

Aerial surveys were made of 3,568,000 acres in nine counties (see maps, pgs. 4 & 5). Ground surveys were conducted over 17,280 acres. Damage from the spruce budworm was decreasing: 109,432 acres of light damage and 16,800 acres of moderate damage (Table 1). Although the acreage of defoliation was substantial, compared to previous years, it showed a significant collapse in spruce budworm-induced damage. This damage was not expected to stress trees severely. Budworm populations probably will take two to three years to rebuild.

Although Luce and Chippewa counties had little remaining mature balsam fir, several white spruce plantations (10 to 15 years old) were heavily defoliated, as happened for the past two to three years.

A control project (two to three acres) was conducted on a West Branch campground using a trailor-mounted mist blower to spray Sevin XLR. The budworm population collapsed in the area after the control operation, however, so the operation could not be evaluated.

Table 1. Acres of spruce budworm damage by county and degree of damage (1981).

	Acres of Damage[1]	
County	Light	Moderate
Alger (w)	20,544	960
Baraga	11,264	-
Delta (w)	7,200	-
Dickinson	19,648	-
Houghton	1,920	-
Keweenaw	5,568	-
Marquette (n)	1,880	-
Marquette (se)	29,008	15,840
Marquette (sw)	4,080	-
Menominee	8,320	-
	109,432	16,800

[1]Light damage: light brown cast over tree; 20 to 25% defoliation of current year's growth.
Moderate damage: light brown cast over tree plus darker brown tree tops; 50 to 90% defoliation of current year's growth.

1982

Aerial surveys made of 2,691,840 acres in eight counties showed spruce budworm defoliation to be at very low levels (Table 2 and maps pgs. 4 & 5). Trees previously defoliated were recovering well.

The United States Forest Service (USFS) conducted an aerial sketch map survey in mid-July for the Ottawa National Forest. Only a few isolated pockets of light budworm

Table 2. Acres of spruce budworm damage by county and degree of damage (1982).[1]

	Acres of Damage[2]	
County	Light	Moderate
Alger (w)	13,290	800
Baraga	23,540	-
Delta (w)	7,320	-
Dickinson	7,270	-
Houghton	1,980	-
Keweenaw	7,190	-
Marquette (n)	1,900	
Marquette (se)	35,970	4,240
Marquette (sw)	4,530	-
Menominee	8,900	-
	111,890	5,040

[1]The slight increase in lightly defoliated acres, compared to 1981 figures, may partially reflect a difference in aerial sketch mapping.

[2]Light defoliation: light brown cast to trees; less than 50% loss of current needles.
Moderate defoliations: tree tops with darker brown cast than lower canopy; more than 50% loss of current needles.

defoliation were visible. The areas of heaviest mortality were the Bessemer, Watersmeet, and Iron River ranger districts.

July 13 through 16 and August 5 and 6, the USFS aerially surveyed the Hiawatha National Forest. Acreage figures are for the western half of the forest, as the eastern part only had small, isolated pockets of light defoliation. Most defoliation was in the Rapid River and Manistique ranger districts. Only standing spruce-fir mortality was mapped (Table 4).

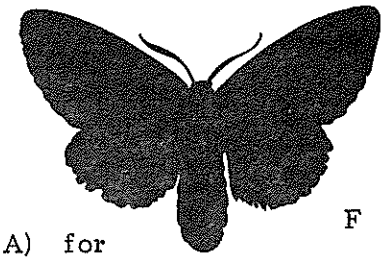
Table 3. Spruce-fir mortality in the Ottawa National Forest (1982).

Tree Mortality		Acres Federal	Acres Private
0-19%	Few	9,576	1,545
20-49%	Moderate	10,909	2,870
50-100%	Severe	33,625	5,462
		54,110	9,877

GYPSY MOTH *(Lymantria dispar)*

1981

Two hundred and fifty traps were distributed throughout the region. Traps with suspect moths were sent to the Michigan Department of Agriculture (MDA) for analysis. No moths were found and no damage was reported.



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1982

One moth was detected, but no egg masses were found. Thus we believe that no established populations are in the Upper Peninsula. As gypsy moth-infested areas in lower Michigan spread, the chances for moths, pupae, and egg masses to enter the Upper Peninsula increase.

Table 4. Spruce budworm damage and spruce-fir mortality in the Hiawatha National Forest (1982).

Damage Type		Acres Federal	Acres Private
Defoliation			
light		3,251	694
moderate		4,889	2,251
heavy		767	358
		8,907	3,303
Tree mortality			
0-19%	Few	9,344	2,155
20-49%	Moderate	7,623	1,588
50-100%	Severe	20,434	3,540
		37,401	7,283

JACKPINE BUDWORM *(Choristoneura pinus)*

1981

No report of budworm populations.

1982

No populations were detected. An epidemic is expected in the next few years, according to historical trends and regional spread patterns through the Lake States.

FOREST TENT CATERPILLAR *(Malacosoma disstria)*

1982

The USFS in cooperation with the Michigan Department of Natural Resources (DNR) aerially surveyed the Upper Pen-insula to detect damage by the forest tent caterpillar. Two counties (Gogebic and Ontanogon) had defoliation over 159,658 acres: 107,742 acres of light defoliation and 51,916 acres of mixed moderate and heavy defoliation. The caterpillar was just beginning to become a problem. This was the first year of defoliation; thus, monitoring will continue until the population collapses.

DISEASES

OAK WILT
(Ceratocystis fagacearum)

1981

Oak wilt was found on red and white oak in Menominee County, with four confirmed epicenters around Shakey Lake. Aerial surveys were conducted over 39,680 acres; 20 acres were ground surveyed. Although previously unreported, the oak wilt problem may have surfaced five years ago. Eradication was recommended.

1982

Oak wilt, which attacks *Quercus* spp., was confirmed in 22 epicenters in Lake Township, Menominee County. Suspected epicenters were detected aerially. Over 1,000 trees have been lost. Oak wilt probably has been in the area for at least ten years, rather than the five years previously supposed.

The MDA, Michigan Technological University (MTU), Cooperative Extension Service, and the county and township cooperated to control the spread of the disease. Vapam was used around residences to create root graft barriers. Frill girdling with 2, 4-D was used in remote areas. All residential areas were treated.

LOPHODERMIUM NEEDLECAST
(Lophodermium seditiosum)

1981

Lophodermium needlecast suddenly appeared during spring lifting in 3-0 red pine at Wyman State Nursery in Manistique. The problem was intially thought to be snow injury. Damaged seedlings were culled, and the rest were shipped. When lophodermium was detected, the remaining seedlings were quarantined.

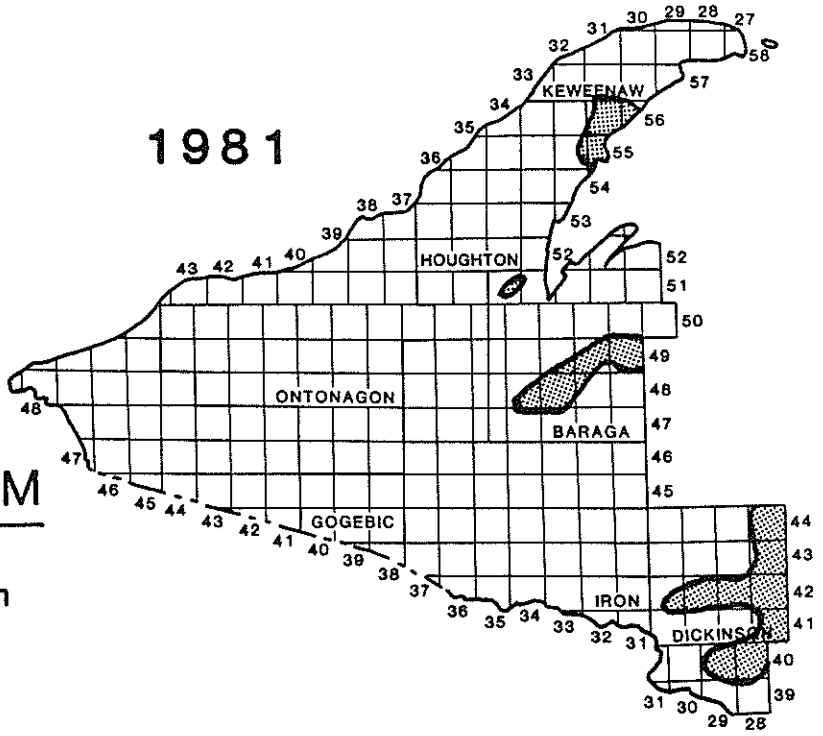
A second planting was done in the spring after the fall planting. The sites planted in the fall with unculled 3-0 red pine had survival rates of 21, 24, 36, 54 and 71%. Although lophodermium caused some of the mortality, planting stress due to the dry spring probably contributed to the losses. Spring plantings using culled stock were doing well.

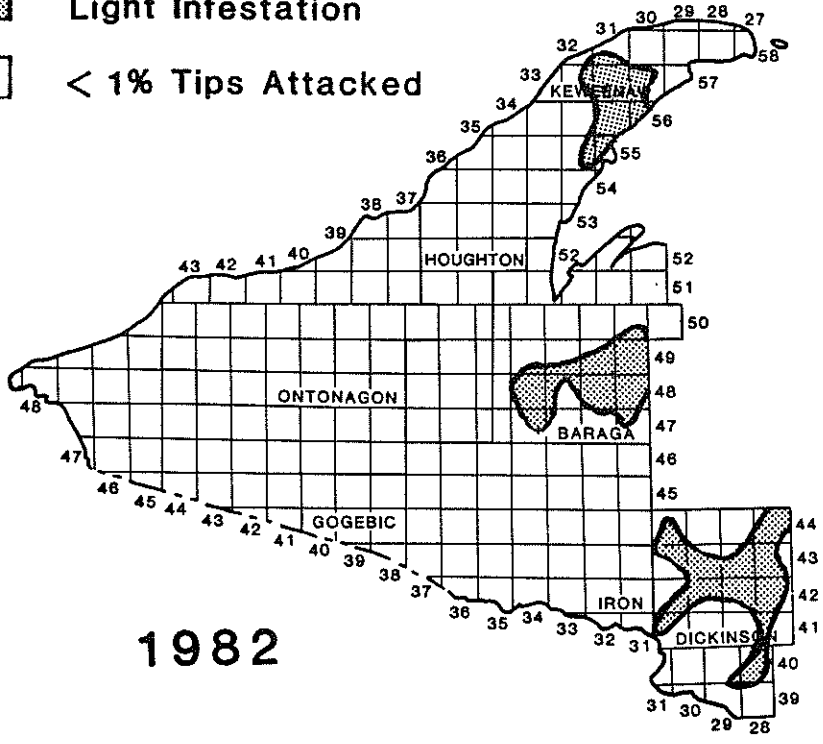
1982

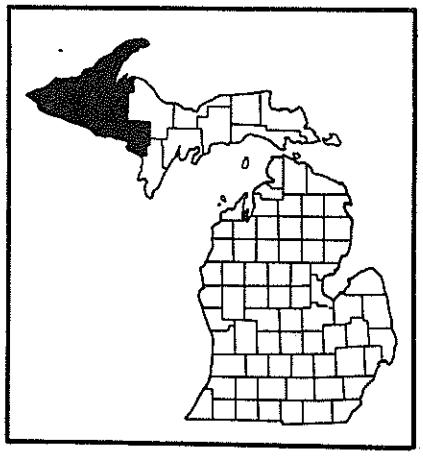
A second evaluation was done in the fall-planted stock. Lophodermium and a dry spring contributed to seedling mortality. The sites were evaluated and found safe from further serious infection (low inoculum potential).

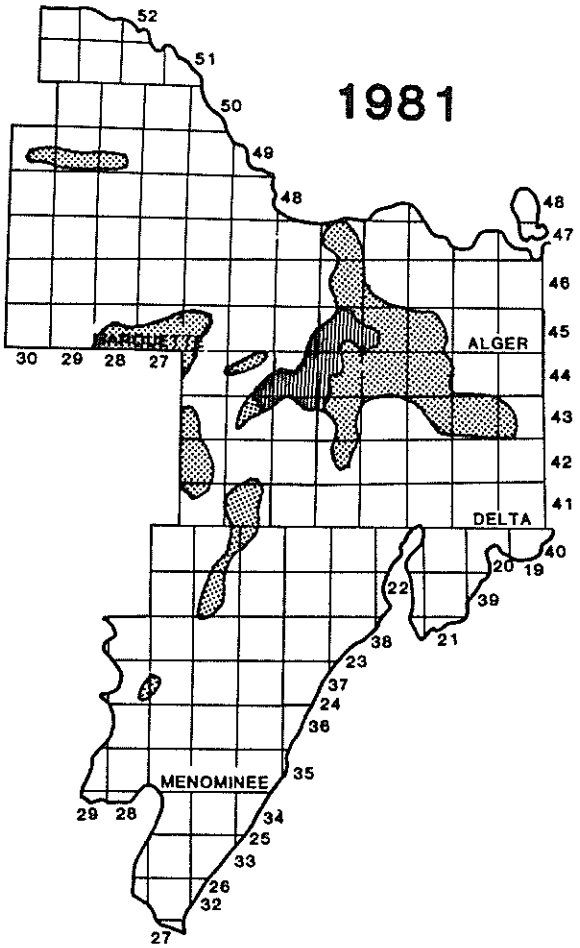
SPRUCE BUDWORM

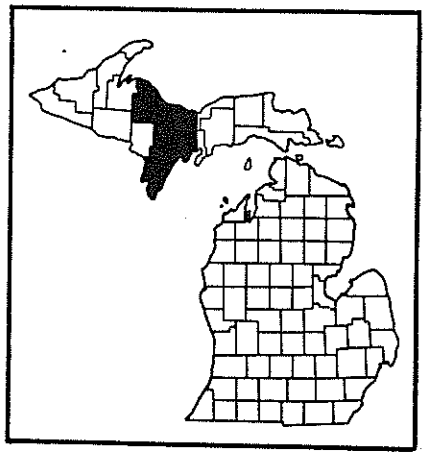
- Extreme Infestation
- High Infestation
- Moderate Infestation
- Light Infestation
- < 1% Tips Attacked

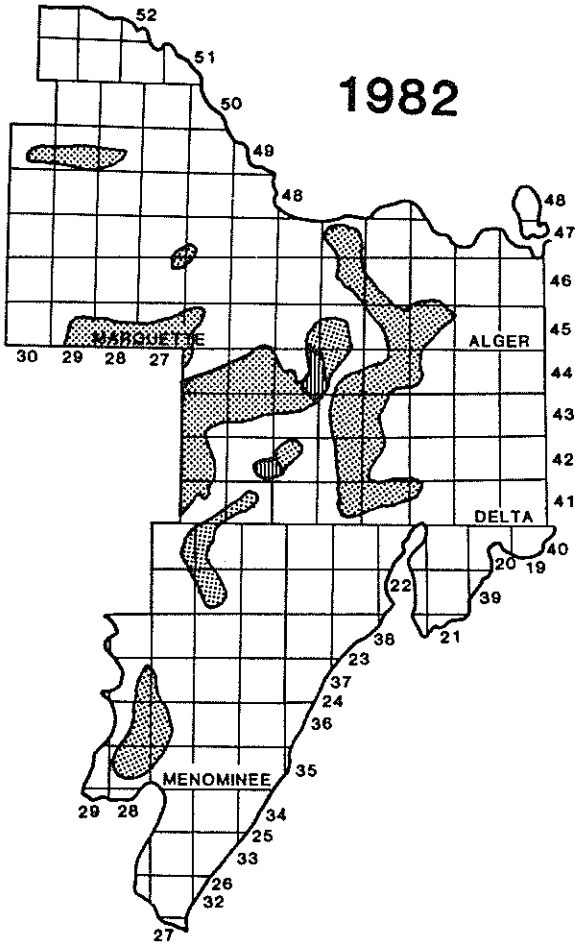












SPRUCE BUDWORM

- Extreme Infestation
- High Infestation
- Moderate Infestation
- Light Infestation
- < 1% Tips Attacked

OTHER PEST PROBLEMS: 1981
Upper Peninsula

Pest	Host(s)	Counties	Remarks
Aspen Blotch Miner *(Lithocolleitus tremuloidiella)*	Aspen	Throughout region	Very noticeable in most areas: 20-100% of leaves affected.
Birch Leafminer *(Fenusa pusilla)*	White or paper birch	Throughout region	Populations seemed to be down this year.
Birch Skeletonizer *(Bucculatrix canadensisella)*	White or paper birch	Throughout region	Very heavy defoliation.
Bladder Gall Mites Eriophyid mites - probably *(Vasates quadripedes)*	Silver and red maple	Throughout region (especially heavy in central U.P.)	Very heavy in areas, many inquires handled.
Bronze Birch Borer *(Agrilus anxius)*	White or paper birch	Throughout the Upper Peninsula	
Diploidia Tip Blight *(Diplodia pinea)*	Red pine	Schoolcraft	Wyman Nursery 1-0 Red Pine - Light Infection; approx. 10% of seedlings with tip flagging in mid-summer. 160 acres ground surveyed.
Drought	Sugar maple	Throughout region	Leaf scorching of crown periphery very noticeable; many calls from concerned people.
Elm Spanworm *(Ennomos subsignarius)*	Northern hardwoods	Schoolcraft, Alger, Luce	Population collapsed this year after being heavy for 3 years. Scattered mortality of mature beech and sugar maple noticeable. 42,500 acres aerially surveyed; 2,100 acres ground surveyed.
White Trunk Rot of Aspen *(Phellinus tremulae)*	Aspen	Throughout region	A large portion of our Aspen resource is over-mature and in need of harvesting. We use only a fraction of our allowable cut.
Forest Tent Caterpillar *(Malacosoma disstria)*	Quaking aspen, sugar maple	Houghton	Moderate defoliation of a small parcel.

Other Pest Problems: 1981 (continued)

Pest	Host(s)	Counties	Remarks
Gall Rusts *(Cronartium quercuum, Endocronartium harknessii)*	Jack and scotch pine	Throughout region	Gall rust prevents jack pine and scotch pine production in some areas.
Hemlock Looper *(Lambdina fiscellaria)*	Eastern hemlock, balsam fir	Menominee	"Large number" of moths noticed and some defoliation of Hemlock reported. Specimens sent in for analysis were adult hemlock loopers.
Hypoxylon Canker *(Hypoxylon mammatum)*	Quaking aspen	Throughout region	
Maple Trumpet Skeletonizer *(Epinotia aceriella)*	Sugar maple	Throughout region	Very heavy populations in some locations. Many calls from concerned people.
Maple Decline	Sugar maple	Marquette, Menominee	Problem continues with a few more trees displaying symptoms of decline or worsening each year.
Oak Mortality *(Archips semiferannus, Agrilus bilineatus, Armellaria mellea)*	Oaks	Chippewa	Archips have collapsed, but the two-lined chestnut borer and shoestring root rot continue to kill stressed trees; especially bad on Sugar Island.
Orange-Humped Mapleworm *(Symmerista leucitys)*	Sugar maple	Dickenson, Alger, Marquette	Three isolated reports without significant defoliation.
Pine Bark Beetles *(Ips pini)*	Jack pine	Baraga	11,500 acres of jack pine on the Baraga Plains T49N, R34W were aerially surveyed: scattered tree mortality and small pockets of activity; 120 acres ground surveyed.
Pine Needle Rust *(Coleosporium asterum)*	Red pine	Baraga	Narrow plantation bordering field of goldenrod.

Other Pest Problems: 1981 (continued)

Pest	Host(s)	Counties	Remarks
Pine Root Collar Weevil *(Hylobius radicus)*	Scotch pine	Thoughout region	May be a limiting factor to scotch pine plantation efforts.
Pine Spittlebug *(Aphrophora cribrata)*	Scotch and white pine	Alger, Schoolcraft	Incidences of mortality of isolated 20-30 ft. white pine.
Red-Headed Pine Sawfly *(Neodiprion lecontei)*	Red pine	Mackinac	Extremely heavy population over approx. 20 acres; 340 acres ground surveyed.
Red Pine Needle Midge *(Contarinia* sp.)	Red pine	East Iron, Dickenson	Pocket of approx. 40 trees in Dickenson Co. with 80-100% loss of this year's needles. First known incidence in MI.
Rhizosphaera Needlecast *(Rhizosphaera kalkhoffi)*	Spruce	Delta, Menominee	Christmas tree plantations.
Scleroderris Canker *(Gremmeniella abietina)*	Red pine	Alger, Schoolcraft, Luce	Light flagging in lower branches in some areas.
Swiss Nedlecast *(Phaeocryptobus gaumannae)*	Douglas fir	Menominee, Delta	Christmas tree plantations.
White Grubs *(Phyllophaga* sp.)	Red pine	Marquette, Menominee	Primary cause of planting failures in some areas; 150 acres ground surveyed.

OTHER PEST PROBLEMS: 1982
Upper Peninsula

Pest	Host(s)	Counties	Remarks
Aspen Blotch Miner *(Lithocolletis tremuloidiella)*	Aspen	Throughout region	Very noticeable in most areas: 20-100% of leaves affected.
Birch Leafminer *(Fenusa pusilla)*	White or paper birch	Throughout region	Populations seemed to be down for the second year in a row.
Birch Skeletonizer *(Bucculatrix canadensisella)*	White or paper birch	Throughout region	Very heavy defoliation; Much public concern.
Bladder Gall Mites Eriophyid mites - probably *(Vasates quadripedes)*	Silver and red maple	Throughout region	Very heavy in localized areas; many inquiries handled.
Bronze Birch Borer *(Agrilus anxius)*	White or paper birch	Throughout region	
Eastern Pine Shoot Borer *(Eucosma gloriola)*	Jack pine	Luce	80 acres with heavy loss of terminal shoots leading to deformities and loss of height growth.
Gall Rusts *(Cronartium quercuum, Endocronartium harknessii)*	Jack and scotch pine	Throughout region	Gall rust prohibits jack and scotch pine production in some areas.
Hypoxylon Canker *(Hypoxylon mammatum)*	Quaking aspen	Throughout region	
Maple Decline	Sugar maple	Marquette, Menominee	Problem primarily confined to urban areas.
Maple Trumpet Skeletonizer *(Epinotia aceriella)*	Sugar maple	Throughout region	Second year in a row with localized areas. Many calls from concerned people.

Other Pest Problems: 1982 (continued)

Pest	Host(s)	Counties	Remarks
Orange-Humped Maple Worm *(Symmerista leucitys)*	Sugar maple	Alger, Chippewa, Dickinson & Marquette	Chippewa County, north of Strongs Corners, noticeable defoliation throughout much of Chippewa Township.
Pine Needle Rust *(Coleosporium asterum)*	Red pine	Menominee County	Christmas tree plantation; 2-3 acres lost.
Pine Root Collar Weevil *(Hylobius radicus)*	Scotch pine	Throughout region	May be a limiting factor to scotch pine plantation effort in the U.P.
Pine Spittlebug *(Aphrophora cribrata)*	Scotch and white pine	Alger, Marquette, Schoolcraft	Abandoned scotch pine Christmas tree plantations; are frequently severely injured.
Red Pine Needle Midge *(Contarinia* sp.)	Red pine	Dickinson, East Iron, Marquette, Menominee	Additional areas detected from previous year. Primarily on young plantations less than 20 years old.
Rhizosphaera Needlecast *(Rhizosphaera kalkhoffi)*	Spruce	Delta, Menominee	Christmas tree plantations.
Scleroderris Canker *(Gremmeniella abietina)*	Red pine	Alger, Luce, Schoolcraft	Light flagging on lower branches in some areas.
Swiss Needle Cast *(Phaeocryptobus gaumamnae)*	Douglas fir	Delta, Menominee	Christmas tree plantations.
White Grubs *(Phyllophaga* sp.)	Red pine	Alger, Marquette, Menominee, Schoolcraft	Primary cause of planting failures in some areas.
White Trunk Rot of Aspen *(Phellinus tremulae)*	Aspen	Throughout region	A large portion of our aspen resource is overmature and in need of harvesting.
Rose Chafer *(Macrodactylus subspinosus)*	Scotch pine	Menominee	20 acres of 3 year old Christmas trees lost much of new growth due to chafer feeding injury on new shoots.

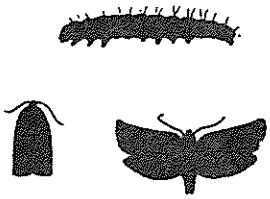
LOWER PENINSULA

LOWER PENINSULA

Ronald Murray
Michigan Department of Natural Resources
Roscommon

INSECTS

JACK PINE BUDWORM (*Choristoneura pinus*)



1981

With 1981 came the most severe jackpine budworm outbreak on record for Michigan. Of the acreage aerially surveyed, 551,000 acres of red and jack pine were damaged by the budworm: 154,109 acres of federal land, 237,352 acres of state land, and 159,513 acres of private land (see maps, pgs. 18-29). Damage ranged from heavy to extreme defoliation with 170,770 acres heavily defoliated, 63,170 acres severely defoliated, and 37,895 acres extremely defoliated (Table 5). Losses occurred mostly to 50-year-old and older stands. Counties hardest hit were Ogemaw, Crawford, Oscoda, and Roscommon.

Plans were begun to salvage up to 26,000 acres of extremely defoliated jack pine. Volume and value losses probably exceeded 3.5 million dollars for over 356,000 cords of standing timber. The value of this timber delivered at the mill was estimated to be $27,183,500.

Permanent plots were established throughout the region to monitor population density, defoliation, and affect of defoliation on tree growth. Populations were predicted to decline in Lake, Grand Traverse, Wexford, Newaygo, Benzie, Leelanau, and Mason counties. High population and damage levels were predicted to continue in other areas, with a possible increase in Montmorency and Clare counties.

The USFS conducted an aerial survey July 15 and 16 of the Huron Manistee National Forest. Jack pine budworm was at outbreak levels in both forests (Table 6b).

Table 5. Acres of jack pine budworm defoliation in land outside of dedicated national forests: 1981 and 1982.

County	Moderate*		Heavy				Severe				Extreme			
	1982		1981		1982		1981		1982		1981		1982	
	State	Private	State	Private	State	Private	State	Private	State	Private	State	Private	State	Private
Arenac	-	980	1,160	60	1,760	260	-	-	-	300	-	-	-	-
Antrim	10,880	360	-	-	-	-	-	-	-	-	-	-	-	-
Benzie	-	-	-	-	-	-	1,680	360	-	-	-	-	-	-
Clare	12,860	10,650	11,210	7,510	560	800	4,520	2,950	-	-	-	-	-	-
Alcona	-	-	-	-	-	-	-	-	-	-	-	-	-	2,280
Crawford	1,280	300	800	1,304	32,640	22,240	53,140	7,620	35,200	23,040	10,591	-	18,580	2,580
Gladwin	-	-	-	-	2,880	160	-	-	-	-	-	-	-	-
Grand Traverse	500	400	-	-	8,960	1,920	5,700	1,160	3,360	300	1,939	2,460	-	-
Iosco		-	8,960	840	-	2,720	2,240	160	9,120	810	-	-	-	960
Kalkaska	6,720	2,080	8,100	2,760	11,560	2,620	-	-	-	-	4,196	-	-	-
Lake	-	-	36,577	28,180	-	-	520	40	-	-	-	-	-	-
Leelanau	-	-	-	-	-	-	1,700	1,860	-	-	800	-	-	-
Mason	-	-	-	10,619	-	-	-	1,160	-	-	-	800	-	-
Missaukee	420	850	5,000	760	-	-	-	-	-	-	-	-	-	-
Montmorency	-	-	8,600	6,200	400	200	-	320	7,080	33,812	-	-	3,400	3,360
Newaygo	-	-	-	10,800	-	-	-	-	-	-	-	-	-	-
Ogemaw	9,000	8,060	240	520	8,980	2,880	6,120	4,120	7,520	2,240	7,029	4,880	12,160	1,140
Oscoda	14,080	9,710	-	1,460	-	-	19,200	14,100	4,000	11,200	800	3,080	-	-
Otsego	-	-	960	400	8,960	5,272	11,760	2,480	1,870	1,470	-	240	7,680	1,740
Presque Isle	580	200	-	-	-	-	-	-	-	-	-	-	-	
Roscommon	-	-	7,010	2,340	46,080	21,120	10,520	5,160	8,320	720	1,000	480	1,240	40
Wexford	1,730	3,040	4,100	4,220	-	5,760	1,460	1,960	-	-	40	360	-	-
TOTALS	58,050	36,630	92,717	77,973	122,780	65,952	118,560	43,450	76,470	73,892	26,395	12,300	43,060	12,100

Moderate: 50-75% of new growth (*category added in 1982)
Severe: 100% of new growth; 50-75% of old growth
Heavy: 75:-100% of new growth; 0-25% of old growth
Extreme: 100% of new growth; 75% of old growth

1982

Areas of extreme and severe defoliation increased over last year's totals: extreme, 73,200 acres; severe, 221,202 acres (see maps, pgs. 18-20). An estimated 624,464 acres of red and jack pine were defoliated: 300,360 acres of state land, 188,574 acres of private land, and 135,530 acres of federal land (Table 5).

Many areas that were not infested heavily in 1981 had greater infestations in 1982. Some lower level infestations began to show signs of population collapse. Larval feeding decreased in some areas from 1981, partly due to cool, rainy weather. However, damage increased despite the reduced feeding because stands continued to decline even with little or no defoliaton. Thirty-eight hundred acres of small trees were treated with Sevin-4-oil to prevent mortality and severe top kill to trees shorter than eight feet. (See pg. 33 for report on spray program.)

Stand conditions deteriorated from 1981. Level I stands totalled 348,798 acres. Level II stands totalled 226,117 acres (Table 7).

Table 6a. Volume and value estimates of growth loss from jack pine budworm damage on state forest and private forest land not within dedicated national forest boundaries: 1981.

Defoliation Class	Growth Loss	Mortality	Total
Heavy	12,807	102,462	115,269
Severe	8,686	44,219	52,905
Extreme	8,526	132,632 to 227,370	141,158 to 235,896
Estimated Value in Dollars			
@$10/cd. Std.	$ 300,190	3,266,820	3,567,010
@$48/cd. F.O.B. Mill	1,440,912	15,680,736	17,121,648

Table 6b. Acres of jack pine budworm defoliation on land within dedicated national forest boundaries.[1]

Damage Type	Federal		Private		Total
	1981	1982	1981	1982	
Defoliation					
Huron National Forest					
light	24,934	33,915	3,993	8,729	71,571
moderate	67,481	50,096	10,188	9,407	137,172
heavy	28,697	46,434	4,249	12,975	92,335
Manistee National Forest					
light	21,017	2,509	5,708	384	29,618
moderate/heavy	11,980	-	2,892	-	14,872
Tree Mortality (1982 only)					
Huron National Forest					
20% few	-	44,182	-	6,299	50,481
20-50% moderate	-	4,300	-	3,047	7,347
50% severe	-	13,594	-	6,581	20,175

[1] From USFS survey.

Table 7. Stand condition levels for jack pine budworm damage: 1982.

County	Stand Condition Level I[1]			Stand Condition Level II[2]			Total
	State	Private	Federal	State	Private	Federal	
Alcona	18,510	4,440	-	2,600	8,190	29,820	63,560
Arenac	-	-	-	-	300	-	300
Clare	-	-	-	4,780	2,500	-	7,280
Crawford	82,304	64,042	-	12,416	8,789	-	167,551
Gr. Traverse	18,901	4,779	-	6,272	2,261	-	32,213
Iosco	280	4,760	8,640	9,140	3,260	2,540	28,620
Kalkaska	26,612	5,080	-	12,000	1,600	-	45,292
Montmorency	7,040	12,000	-	8,080	16,785	-	43,905
Ogemaw	31,360	10,240	-	7,280	5,760	-	54,640
Oscoda	11,440	21,600	5,440	600	31,000	43,520	113,600
Otsego	4,320	1,760	-	9,440	2,720	-	18,240
Roscommon	4,640	600	-	6,960	22,720	-	32,920
Wexford	-	-	-	4,104	680	-	4,784
TOTAL:	205,407	129,301	14,080	83,672	106,565	75,880	614,905

[1] Average 35% mortality during the rest of the infestation; top kill and deformity; 90% growth loss in current year.

[2] Less than 10% mortality during the rest of the infestation; top kill and deformity; 55% growth loss in current year.

Infestations probably will increase in western Montmorency and northeastern Otsego counties. Some high level populations showed signs of collapse. Lower level infestations in Clare, Lake, Wexford, and western Kalkaska counties are expected to decrease dramatically in 1983. (See pg. 30 for overwintering larval survey.)

The USFS aerially surveyed the Huron-Manistee National Forest on July 28, 29, and 30. Mortality and defoliation on the Manistee National Forest was light and scattered. Most of the current defoliaion was found on the northern portions of the Cadillac and Manistee ranger districts (Table 6b).

RED PINE SHOOT MOTH (*Dioryctria resinosella* Mutuural)[1] and Eastern Pine Shoot Borer (*Eucosma gloriola*)

1981

Infestations were more severe than in 1980. Of the 170,000 acres surveyed, all red pines over 30 feet tall were infested to some degree (see maps, pgs. 21-23). Trace and light

[1] Previously known as Zimmerman Pine Moth (*Dioryctria zimmermani*)

infestations were generally along well-traveled roads.

A breakdown of infestation showed that 67% of the tips were infested by the red pine shoot moth, 17 to 35% by the Eastern pine shoot borer, and 0 to 15% by other causal agents, such as weevils and early sawflies.

Little is known about the biology and population dynamics of these pests; therefore, the extent of future damage cannot be predicted.

1982

The area of infestation and the severity of infestation decreased from 1981 (see maps pgs. 21-23). Most red pine over 30 feet tall, however, continued to be infested to some degree. Infestations ranged from 90% of tips to a few scattered tips per stand. Over one million acres had low infestations (1,013,760 acres); 316,160 acres had moderate infestation; and 647,040 acres had high infestations.

WHITE PINE WEEVIL (*Pissodes strobi*) (Peck)

1981

Twenty-seven jack pine stands were surveyed for pine weevil damage (689 acres). Damage on jack pine ranged from 3 to 75% of trees in a stand that were weevilled. Substantial losses were expected. Many ten-year-old stands in the Pere Marquette Forest were unmerchantable due to reduced growth and poor form.

Populations have been increasing slowly over the last 20 years. Damage will probably increase in Mackinac and AuSable counties, while populations in Pere Marquette will remain high.

Average percent of current year weeviling of jack pine found in 47 sample plots.

State Forest	1980	1981
Mackinac	23.1	26.4
Pere Marquette	11.1	29.1
AuSable	35.1	65.4

(Information for 1982 not available.)

1982

Populations increased over 1981. Jack and white pines were damaged in all counties; however, the white pine weevil most heavily damaged jack and white pines in Lake, Wexford, Grand Traverse, Kalkaska, Antrim, and Crawford counties.

Populations are expected to increase.

SARATOGA SPITTLEBUG (*Aphrophora saratogensis*) (Fitch)

1981

The Saratoga spittlebug was found throughout the northern Lower Peninsula. Aerial surveys were made of 1,598 acres: 1,394 acres were rated moderate to high risk. Ground surveys found only one area with damaging levels of the spittlebug. This population, found in Wexford County in a 10-year-old red pine plantation (60 acres) caused growth loss and branch mortality.

Populations were building in other areas. Crawford, Gladwin, Ogemaw, and Missaukee counties had problems serious enough to warrant control in 1982.

Ninety-seven stands were evaluated as to past damage (over the past 10 to 20 years). In these stands, 23% of the trees were undamaged, 15% had slight damage and would recover, 11% were reduced in grade to pulpwood-chips, 9% were unmerchantable, and 41% were missing. Damage could be lessened by (1) not planting pines in alternate host areas, (2) controlling the alternate host with herbicides, and (3) monitoring pest populations and controlling adult spittlebugs with insecticides.

1982

Population levels were monitored on 1000 acres of red and jack pine plantations where previous surveys had indicated potentially damaging populations could develop. In these plantations, populations ranged from 0 to over 2 nymphs per tree unit. Populations with over 2 nymphs per tree unit were suppressed chemically. Losses were minimal because of strict population monitoring. Low volume Cythion, applied aerially on 153

acres of red pine, reduced the adult population to acceptable levels.

Populations could again increase to damaging levels in three to four years with suitable alternate hosts.

Plantations in high and moderate risk areas will continue to be monitored. Plans were made to reduce the alternate host in 1983 using Glyphosphate.

Acres found with Saratoga spittlebug: 1981.

County	Acreage	Acres at Risk
District 5		
Antrim	170	High: 768
Cheboygan	38	
Montmorency	312	Moderate-High:
Otsego	213	49
Presque Isle	84	
	817	
District 6		
Kalkaska	327	High: 328
Lake	19	
Missaukee	44	Moderate-High:
Wexford	58	120
	448	
District 7		
Crawford	210	High: 297
Gladwin	20	
Ogemaw	102	Moderate-High:
	332	35

ELM SPANWORM
(*Ennomos subsignarius*)

1981

Within the 474,840 acres surveyed, all host trees (elm, beech, basswood, and birch) were infested (see map, pg. 24). In this five-county area (Charlevoix, Antrim, Otsego, Cheboygan, and Montmorency), beech was almost totally defoliated, especially understory trees, and basswood was heavily defoliated. Beech could have some mortality from the defoliation. More work on this infestation is being planned, if needed.

1982

Populations were down from levels in previous years (see map, pg. 24). The elm spanworm was found in Otsego and Montmorency counties, only.

PINE SPITTLEBUG
(*Aphrophora cribrata*)

1981

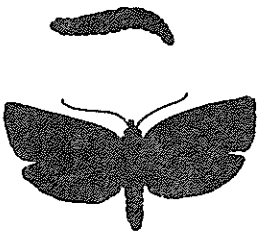
The pine spittlebug was found throughout the region attacking scotch, jack and white pines. Damage this year was heavier than last year, with severe spot infestations on ornamentals and plantations. Homeowners were particularly concerned about damage to their ornamentals. Plantations on state and private lands experienced patches, about one acre in size, of tree mortality.

1982

Very severe spot infestations were found on ornamentals and plantations. This pest continued to be of particular concern to homeowners, but it also caused some losses in forest plantations on state and private lands. Populations probably will remain heavy and widespread. No control projects are being planned.

ASPEN LEAFROLLER COMPLEX: LARGE ASPEN TORTRIX
(*Choristoneura conflictana*) and *Anacampsis* sp.

1981



Aspen stands were damaged as heavily this year by the aspen leafroller complex as in 1980 (see map, pg. 25). Infestations were greatest in the upper part of the Northern Lower Peninsula. The most severely hit counties were Cheboygan, Emmet, Presque Isle, Charlevoix, Montmorency, Alpena, Missaukee, Grand Traverse, Kalkaska, Roscommon, Ogemaw, Arenac, Gladwin, Clare, and Midland. Most aspen stands were severely defoliated, with top kill and tree mortality occurring in off-site situations.

1982

The heavy infestations of 1981 began collapsing in many areas in 1982. Defoliation still occurred on wide areas. The severity of the defoliation ranged from light to almost complete tree defoliation.

Top kill and tree mortality continued in off-site areas. Past damage coupled with additional defoliation in 1981 caused serious crown dieback on many of these trees. Good sites may also sustain some long-term damage. Populations are expected to decrease in 1983.

RED-HEADED PINE SAWFLY (*Neodiprion lecontei*)

1981

Infestations were found on 350 acres in Wexford and Roscommon counties, primarily on young jack pine 6-feet tall and under. One area of tree mortality was confirmed in Roscommon County, near Higgins Lake. Several areas were infested in Wexford County: 120 acres had heavy losses, 160 acres had moderate losses, and 40 acres had light damage.

Populations were rising, with high levels expected in 1982. No controls were implemented.

1982

Single trees in some Wexford County plantations were completely defoliated in the summer of 1982. Infestations were spotty and confined to areas of stress. Populations previously found scattered over the region were not detected. Experimental pheromone trapping, in cooperation with the University of Wisconsin and the USDA-Forest Service NCFES, detected the insect over approximately 100 square miles in Wexford County on the Huron-Manistee National Forest.

Epidemic levels probably will continue in Wexford County. Other areas of previous infestion will be surveyed in 1983.

DISEASES

OAK MORTALITY

Oak Leafroller (*Archips semiferanus*);
Two-lined Chestnut Borer (*Agrilus bilineatus*);
Shoestring Root Rot (*Armellaria mellea*)

1981

This pest complex, found throughout the Lower Peninsula, attacks red, black, and white oaks. Oak leafroller populations were tapering off to low levels this year. Drought-stressed trees in Roscommon, Crawford, Oscoda, Ogemaw, Kalkaska, Missaukee, and Lake Counties had heavy infestations of the secondary invaders: two-lined chestnut borer and shoestring root rot. Some oaks were dying--from a few per acre to many per acre in patches and blocks. Continued damage from these pests can be expected in the next few years on stressed trees. Damaged trees can be used for firewood. Many were being salvaged.

1982

Some mortality continued to occur. Accessible trees continued being cut for firewood.

PINE WILT DISEASE

Pinewood nematode (*Bursaphelenchus xylophilus*)

1981

The causal organism of pine wilt disease was discovered in late autumn of 1980. Two confirmed pine wilt-diseased trees were found in 1981 in scotch pine in home landscape plantings in Ingham County. A formal study for the pest has not been initiated.

1982

No reports of pine wilt-pinewood nematode.

OAK SPROUT MORTALITY (*Dothiorella quercina*)

1982

A survey was conducted of 8% of the oak stands clearcut in the last 21 years in the

Huron-Manistee National Forest. Cankers were the major cause of sprout death. Eleven stands (20%) averaged one or more cankers per sprout. *Dothiorella quercina*, a fungus that infects stressed oaks, was associated with many of these cankers.

Sprout mortality is seriously reducing stocking of many of these stands. Interplanting may be necessary to insure an acceptably-stocked stand by rotation age.

RHABDOCLINE NEEDLECAST
(Rhabdocline pseudotsugae)

1982

Rhabdocline needlecast was very serious in northwest Michigan Douglas Fir plantations. Needles show distinct reddish-brown and green splotches. Fruiting bodies appear in early June, but are difficult to discern even with a microscope. Chlorothalonil (Daconil 2787) must be applied when needles are beginning to expand in late spring.

DIPLODIA TIP BLIGHT
(Diplodia pinea)

1982

Diplodia tip blight leveled off after two years of increased incidence. The fungus kills only the branch terminals of Austrian and Scotch pine. Fruiting bodies of the fungus are found at the base of dead needles under the needle sheath and on cones. Copper fungicides do a good job of control if applied at needle break and again 10 days later.

RHIZOSPHAERA NEEDLECAST
(Rhizosphaera kalkhoffi)

1982

Rhizosphaera needlecast continued to plague spruce. Fungus fruiting bodies protrude through the stomates leaving rows of black dots where there would normally be white dots.

WESTERN GALL RUST
(Endocronartium harknessii)

1982

Western gall rust had an economic impact on hard pines, especially Scotch and Jack. The rust has no alternate host, so it can be controlled more easily with fungicides. Swellings occur on branches. Bright orange spores are shed in May and June.

MAPLE DECLINE

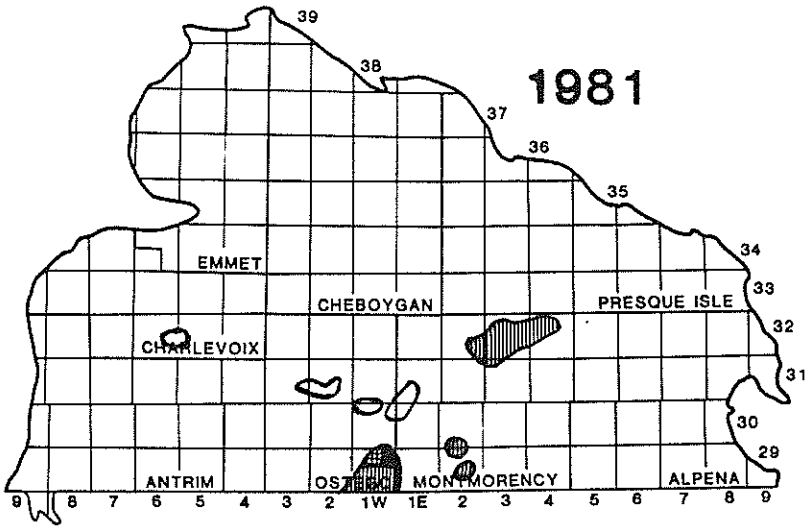
1982

Maple decline was still of great concern to homeowners and municipalities. Symptoms include dieback of uppermost branches in older trees, early fall coloration, and leaf scorch. Decline often results from basal trunk cankers *(Phytophthora* and *Fusarium)* that attack trees planted too deeply. Maples survive best when allowed a natural root flair.

VERTICILLIUM WILT
(Verticillium albo-atrum)

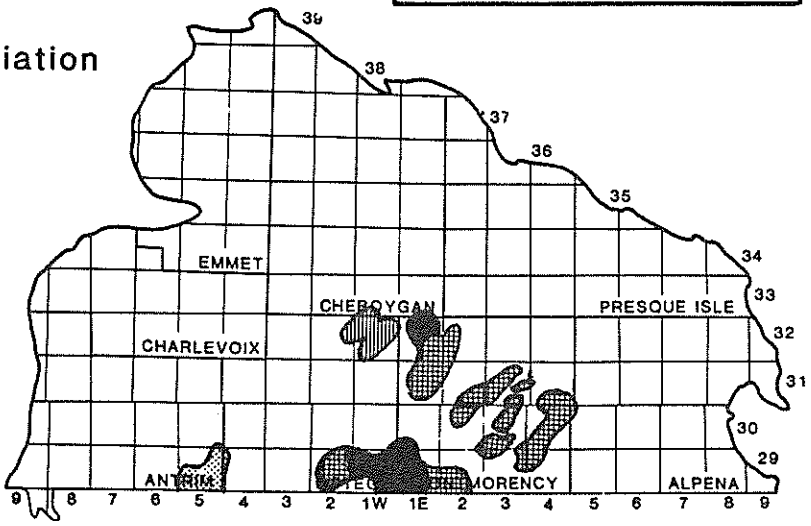
1982

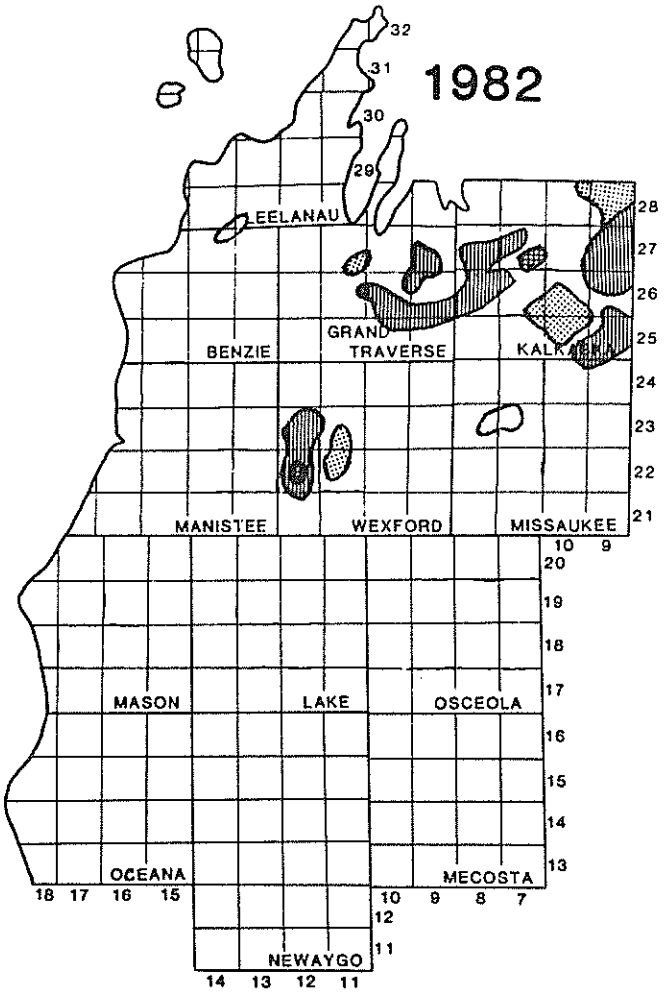
Verticillium wilt increased in maple after periods of drought stress. The fungus lives in the soil, penetrates roots of weakened trees, and plugs the water conducting system causing sudden wilt in portions of the tree crown. Brown or olive green streaking can be found in the sapwood. No control is known.

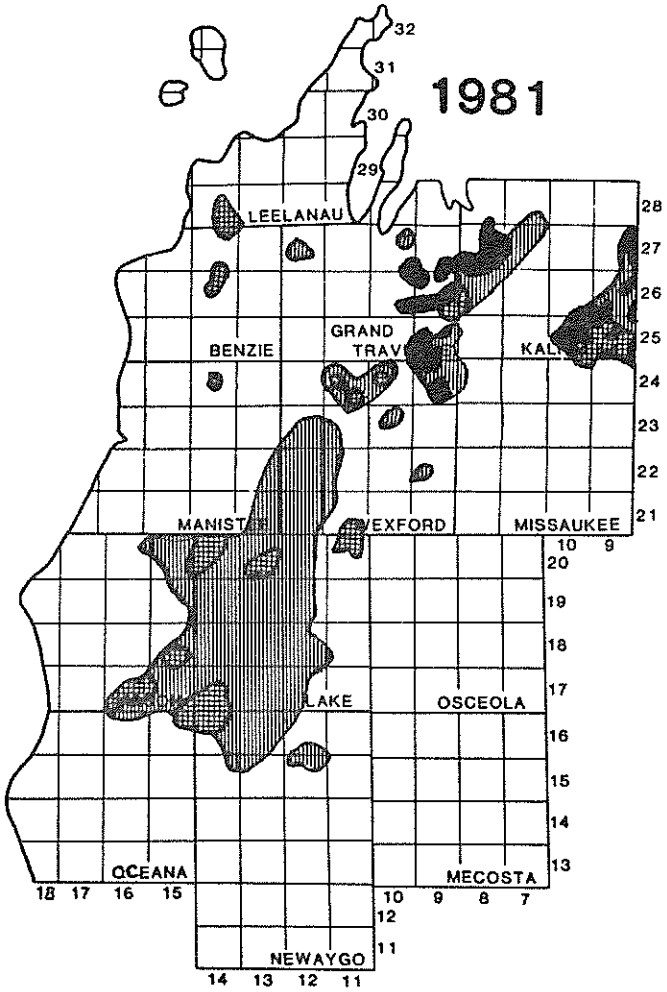


JACK PINE BUDWORM

- Extreme Defoliation
- Severe Defoliation
- Heavy Defoliation
- Moderate Defoliation
- Light Defoliation







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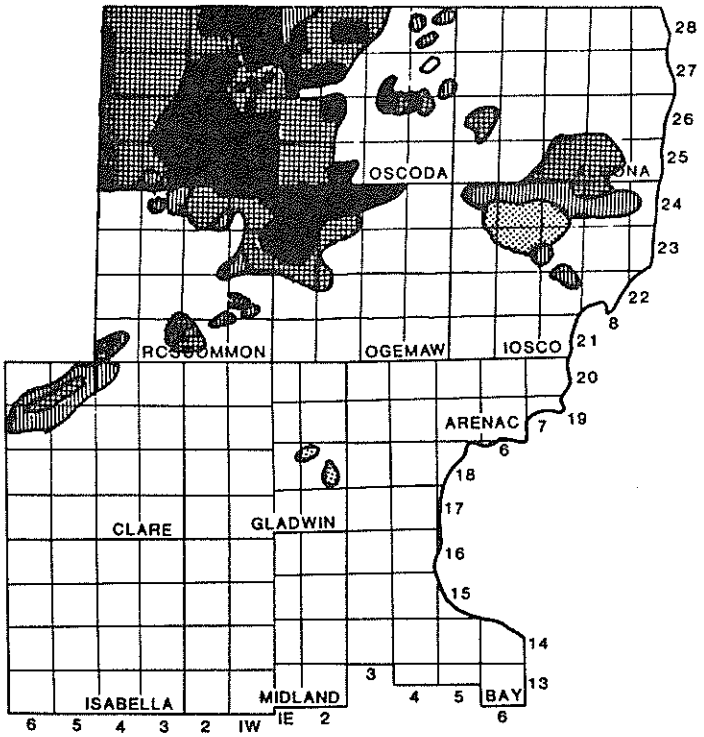
1981
JACK PINE BUDWORM
Extreme Defoliation
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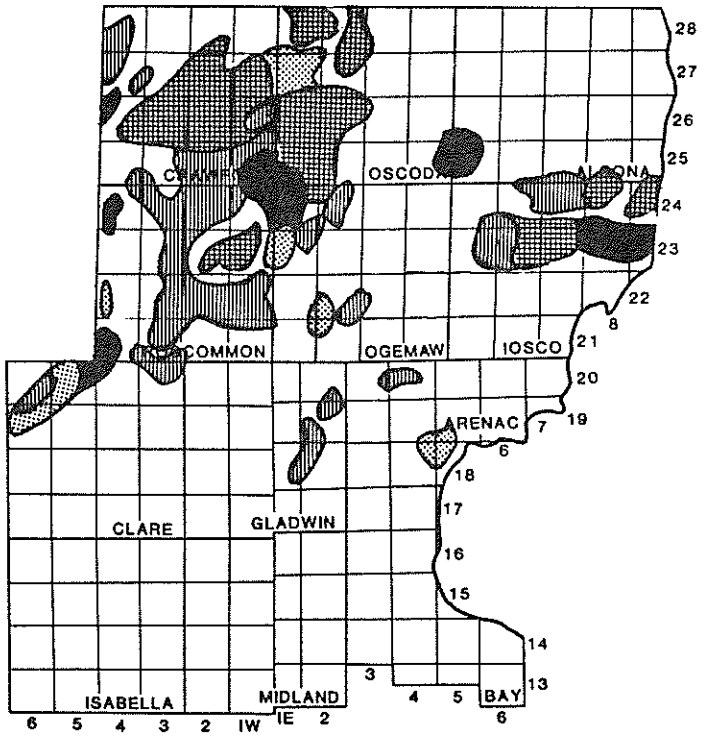
OSCODA
IOSCO
OGEMAW
ARENAC
CLARE
GLADWIN
ISABELLA
MIDLAND
BAY


1982
OSCODA
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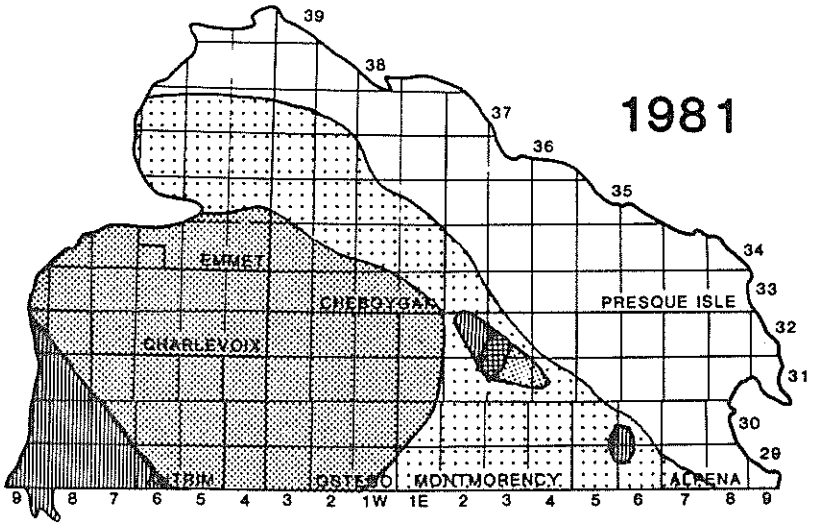
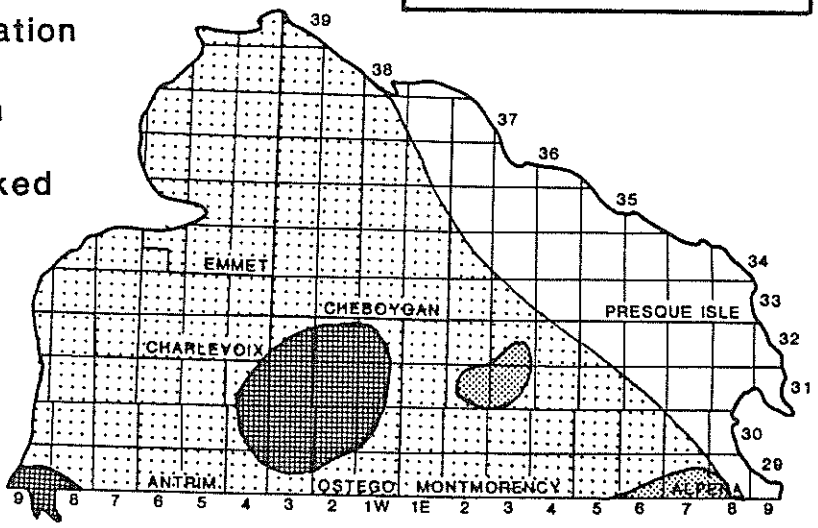
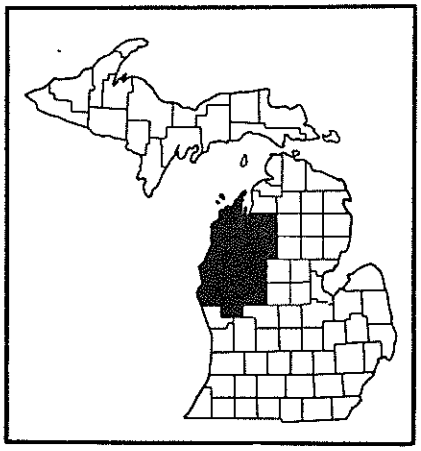
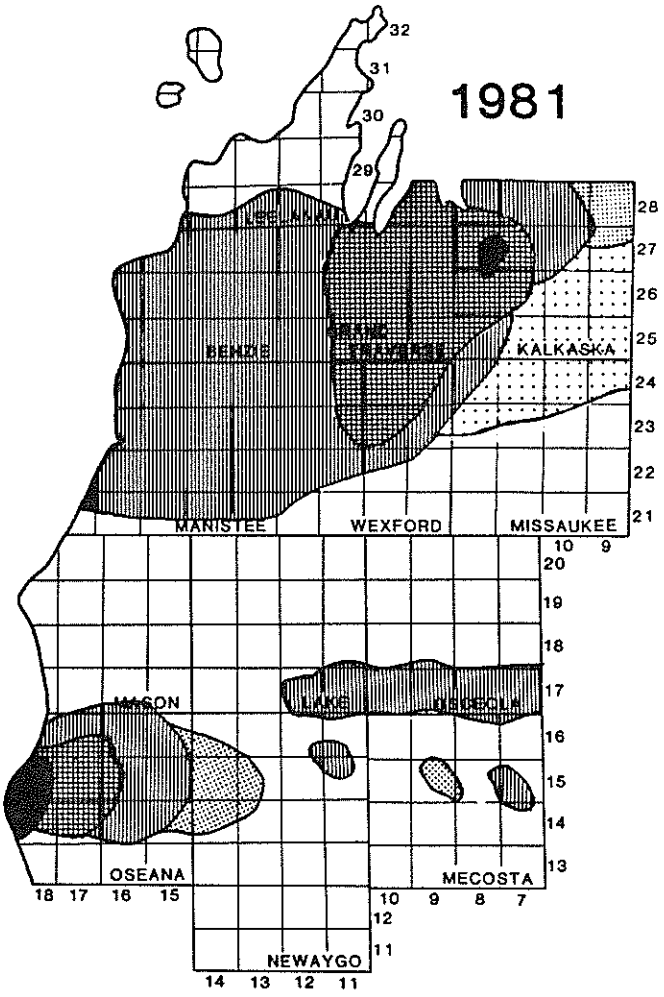


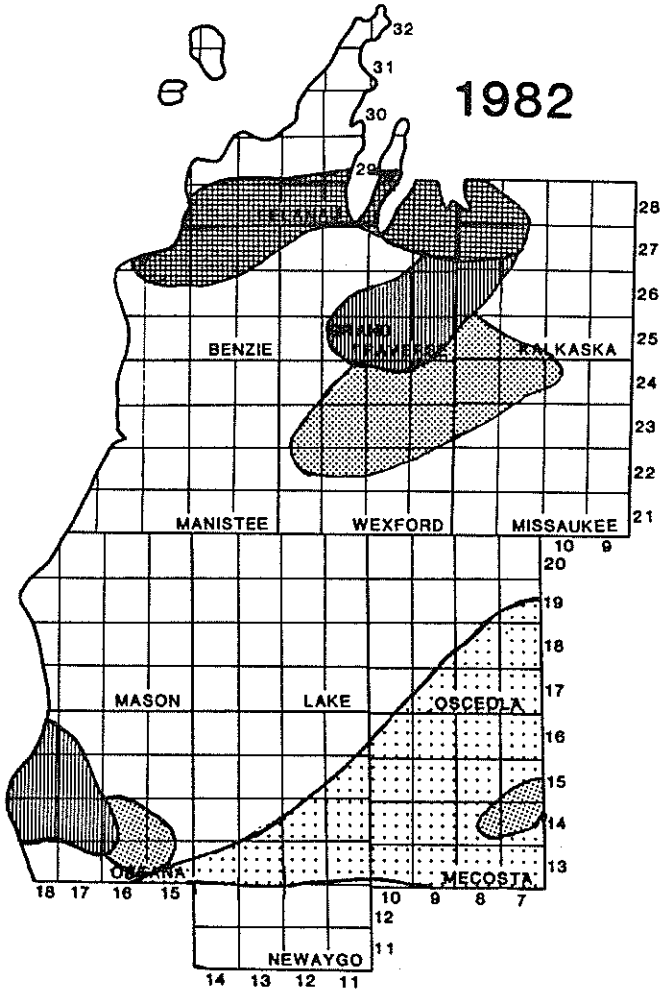
RED PINE SHOOT MOTH/ EASTERN PINE SHOOT BORER

- Extreme Defoliation
- High Defoliation
- Moderate Defoliation
- Light Defoliation
- < 1% Tips Attacked









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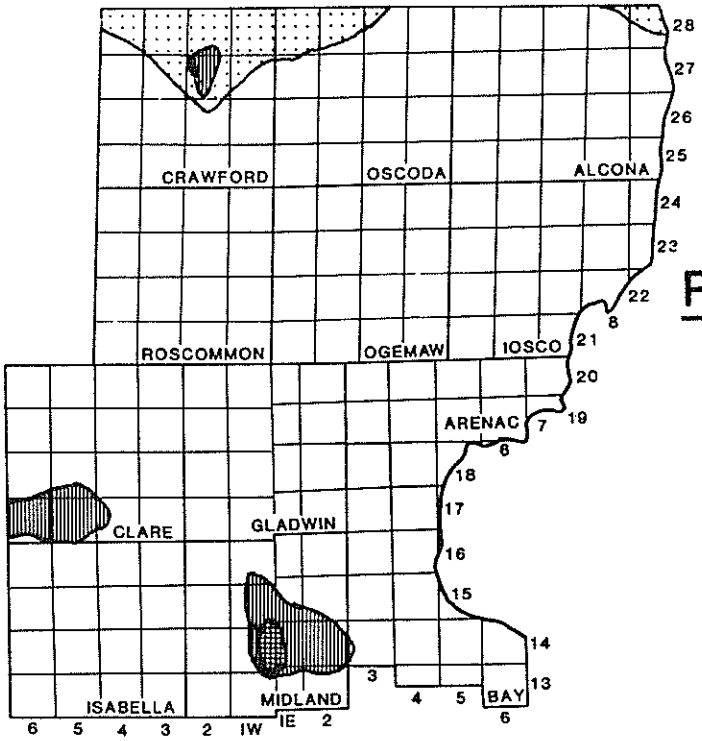

1981

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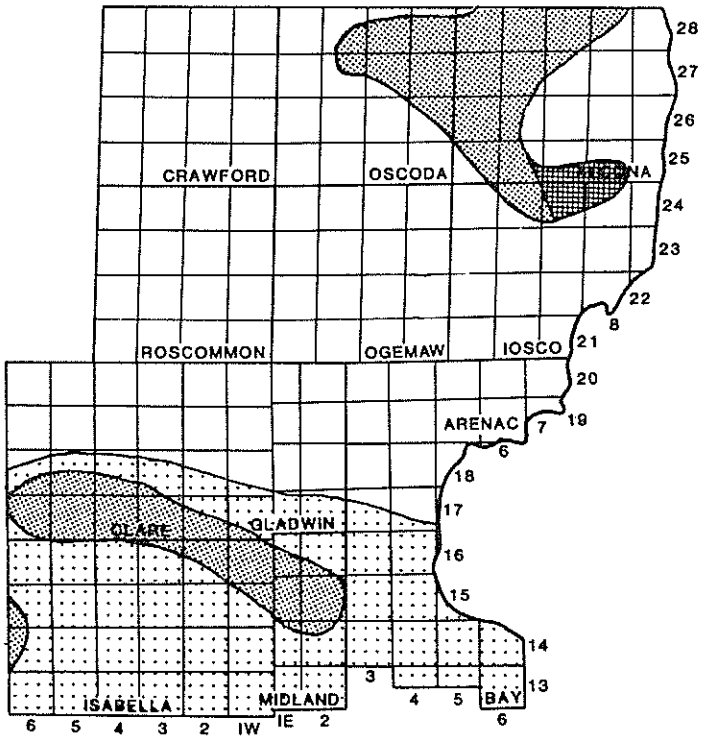
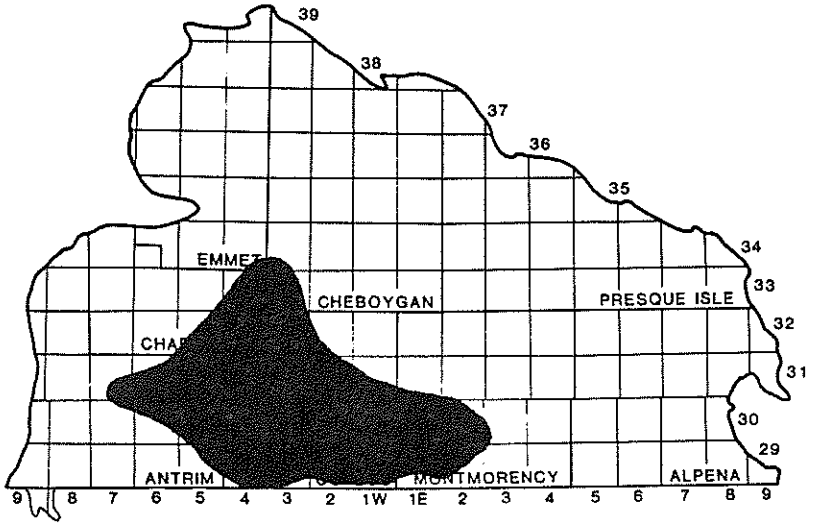


1982

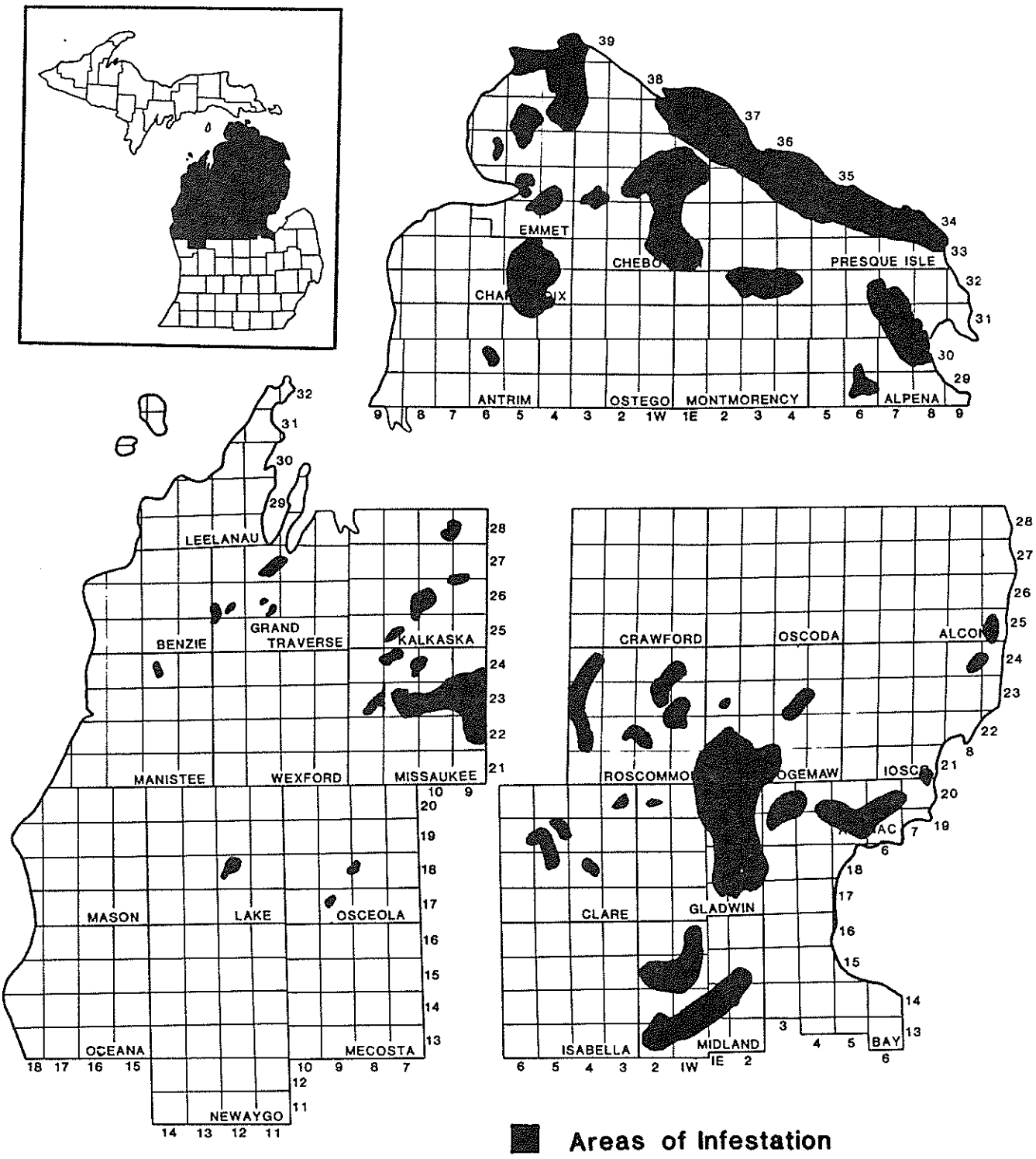


1981-1982

ELM SPANWORM

■ Heavy Defoliation

1981 ASPEN LEAF ROLLER COMPLEX



OTHER PEST PROBLEMS: 1981
Lower Peninsula

Pest	Host	Counties	Remarks
Spruce Budworm *(Choristoneura fumiferana)*	Balsam fir, spruce	Charlevoix, Emmet, Otsego, Montmorency	Scattered light infestations.
Bark Beetles *(Ips pini)*		Throughout region	Small areas infested in trees stressed by drought or other factors.
European Pine Sawfly *(Neodiprion sertifer)*	Pines	Throughout region	The second year of high populations of this pest.
Introduced Pine Sawfly *(Diprion similis)*	Red pine	Wexford, Benzie	Some isolated colonies were located on State and USFS lands.
Oak Leafroller *(Archips semiferanus)*	Oak	Roscommon, Crawford, Ogemaw, Lake	Population very low compared to last year.
Maple Leaf Cutter *(Paraclemensia acerifoliella)*	Northern hardwoods	Benzie, Manistee	Approximately 1,000 A of heavy infestation on private land.
Sclerroderris *(Gremmeniella abietina)*	Red pine		Although all "possible" reports are investigated, no new infestations have been found.

OTHER PEST PROBLEMS: 1982
Lower Peninsula

Pest	Host	Counties	Remarks
Oak Skeletonizer *(Buccalatrix ainshiella)*	Oaks	Grand Traverse Kalkaska, Roscommon Crawford	Some infestations heavy, although impact is slight because damage occurs as late season defoliation. Damage may be significant in southern portions of the state where two generations may occur.
Maple Trumpet Skeletonizer *(Epinotia aceriella)*	Sugar & red maple	Emmet, Grand Traverse, Kalkaska	A late season defoliator of little economic importance. May be a nuisance pest to homeowners.
Maple Leaf Cutter *(Paraclemensia acerifoliella)*	Sugar maple red maple, beech, birch elm	Benzie, Manistee	Approximately 1000 acres of moderate to heavy infestation.
Pine Bark Beetles *(Ips pini)*	Pines	Throughout region	Small areas in trees affected by other stress factors, i.e. drought, defoliation.
Pine Needle Sheathminer *(Aellana haimbachi)*	Jackpine	Montmorency	Heavy infestation detected although defoliation apparently light. This insect has not yet become important in the Lake States.
Rose Chafer *(Macrodactylus subspinosus)*	Many species	Roscommon, Crawford, Antrim, Otsego, Kalkaska	Primarily a pest of ornamentals, but several individuals found in pine plantations.
Pine Chafer *(Anomala oblivia)*	Jack, red, white and scotch pine	Throughout region	Scattered infestations, damage slight.
Spruce budworm *(Choristoneura fumiferana)*	Balsam fir	Missaukee, Kalkaska	Light infestation detected on private land.
Jack Pine Sawfly *(Neodiprion pratti banksianae)*	Jack, red and scotch pine	Roscommon	A few colonies found on private land.

Other Pest Problems: 1982 (continued)

Pest	Host	Counties	Remarks
European Pine Sawfly *(Neodiprion sertifer)*	Pines	Throughout region	Population down from previous years, damage slight.
Sclerroderris *(Gremmeniella abietina)*	Red pine		Although possible infestations investigated, no new infestations found.
Frost Damage	Aspen, jack pine	Throughout region	Jack pine hit in conjunction with budworm defoliation may have caused increase topkill.

SURVEYS, CONTROL PROGRAMS,

PILOT TESTS, AND

RESEARCH REPORTS

SURVEYS

GYPSY MOTH SURVEY: 1981 and 1982 (B. Smith, USDA/APHIS)

1981

Gypsy moth traps (20,000) were set out in several Michigan counties to detect new infestations and to delimit previously detected infestations. Detection trapping caught 347 moths in 23 counties. Moths were recovered in Hillsdale, Jackson, Lapeer, Lenawee, Oscoda, and Presque Isle counties for the first time.

Delimit trapping in areas of previous infestations caught 7,533 moths in 12 counties. Of these, 7,192 moths were recovered from Saginaw County. Saginaw County will be put under regulation.

Spray blocks were established at four locations (3,100 acres): (1) Grand Traverse County, Peninsula Township, (2) Muskegon County, Norton Township, (3) Ottawa County, Grand Haven Township, and (4) Roscommon County, Nister Township. Plans were to treat these areas in May and June, 1982, with Sevin 4-oil.

Gypsy moth populations were reduced 85% in Berrien County, Hagar Township, using a sterile male release program. This was the third year of the program. In Kent County, Calidonia Township, 530 acres were treated with *B.t.*, followed by a disparlure treatment. These treatments will be duplicated in 1982.

1982

The gypsy moth trapping program was expanded to include a detection survey, a delimit survey, and a monitoring survey. The survey was conducted in 41 counties with 16,700 Delta traps. The traps were designed to attract and capture male gypsy moths; 7,579 moths were recovered from 2,169 traps in 35 counties.

For the detection survey, 3,950 traps were placed in 19 counties in the central portion of the Lower Peninsula. Trap densities were one per square mile and one per three square miles. From 1,232 traps, 5,757 moths were recovered. Gypsy moths were recovered from Sanilac and Mason counties for the first time.

Additional traps placed in some northern counties recovered one moth in Menominee County and one moth in Leelanau County (west of Traverse City). Two moths were found in traps in the National Forest Campgrounds (Newaygo and Iosco counties) by the USFS.

For the delimiting survey, 12,808 traps were placed in 24 counties, mostly in the southern half of the Lower Peninsula, at 16 per square mile. Trap catch was 1,752 moths in 19 counties. Two delimit sites in Oscoda and Presque Isle counties were negative.

Traps for the monitoring survey were placed in areas that had been treated in 1981 and 1982. Only 47 moths were recovered. These were in the Muskegon treatment area.

From these surveys, plans were developed to treat seven areas (2,845 acres) in 1983.

Kalamazoo Co./Portage Twp.:	720 A
Van Buren Co./Antwerp Twp.:	360 A
Muskegon Co./Norton Shores Twp.:	160 A
Livingston Co./Hamburg Twp.:	775 A
Livingston Co./Hartland Twp.:	30 A
Oakland Co./Highland Twp.:	500 A
Oakland Co./Farmington Twp.:	300 A

The quarantine area was expanded because of the pattern of trap catches. New counties in the quarantine area are Arenac, Gladwin, Oscoda, Genesee, and Oakland. The expansion also added previously unregulated areas of Bay, Clare, Gratiot, Mecosta, Midland, and Montcalm counties.

Although the infested area expanded, visible damage was low. Defoliation was reported only on 92 acres in Gratiot, Isabella, and Midland counties.

JACK PINE BUDWORM OVERWINTERING LARVAL SURVEY: 1981 and 1982 (F. Sapio and G. Simmons, MSU; R. Murray, DNR)

The jack pine budworm *(Choristoneura pinus pinus)* has long been a serious pest of commercial jack pine production in Michigan. These studies were conducted to determine levels of overwintering 2nd instar larvae on the host jack pine trees and to provide a biological yardstick to use in appraising management options. Field-collected samples of jack pine branches were collected from areas of jack pine budworm-damaged stands. The samples were evaluated by the forest entomology laboratory at MSU for jack pine budworm larvae.

The following table compares the number of overwintering larvae found per branch in 1981 and 1982. Overall, the budworm population has decreased from 1981. Populations are expected to continue this decline.

Comparison of the 1981 and 1982 jack pine budworm overwintering larval survey (estimated overwintering larvae/100 cm branch sample)

County	Location	Overwintering larvae/branch (100 cm)	
		$\bar{x}$ 1981	$\bar{x}$ 1982
Cheboygan	T34N, R2W, S.9	35	49
Montmorency	T32N, R2E, S.9	45	34
	T31N, R3E, 5.8	48	25
	T31N, R3E, S.13	78	55
	T31N, R2E, S.5	130	20
Otsego	T29N, R1W, S.2	117	22
Kalkaska	T27N, R8W, S.22	89	20
	T27N, R8W, S.14	67	18
	T27N, R5W, S.36	115	105
	T26N, R6W, S.5	130	22
	T26N, R6W, S.2	77	26
	T25N, R6W, S.24	43	22
Clare	T20N, R6W, S.34	44	6
	T20N, R6W, S.13	27	7
	T20N, R6W, S.34	16	8
Lake	T19N, R13, S.14	13	9
Antrim	T29N, R5W, S.25	110	27
Missaukee	T27N, R5W, S.26	18	11
Benzie	T27N, R14, S.1	3	3
Grand Traverse	T27N, R9W, S.27	22	6
	T26N, R9W, S.20	33	30
	T26N, R9W, S.21	97	26
	T26N, R9W, S.21	64	19
	T27N, R9W, S.11	17	9
Crawford	T27N, R3W, S.33	77	99
	T26N, R2W, S.2	156	78
	T27N, R1W, S.25	79	5
	T27N, R3W, S.23	65	18
	T25N, R4W, S.30	78	35
	T25N, R3W, S.2	38	17
	T25N, R4W, S.27	63	13
Ogemaw	T24N, R2E, S.22	115	5
	T24N, R2E, S.17	62	18
	T24N, R2E, S.7	174	11
	T23N, R1E, S.20	276	9
Oscoda	T27N, R1E, S.12	126	31
	T27N, R1E, S.18	8	30
Roscommon	T24N, R1W, S.33	15	30
	T24N, R2W, S.27	75	156

ARMILLARIELLA ROOT DISEASE RISK EVALUATION: 1981 (J. N. Bruhn, MTU)

Certain species of *Armillariella* cause serious mortality in conifer plantations following hardwood liquidation. *Armillaria mellea*, the common "stump mushroom" of northern hardwoods, is a complex of *Armillariella* species, some of which cause serious root disease. Work is underway to determine the distribution and ecology of *Armillariella* "biological species" found in the Upper Peninsula. It should be possible to develop a predictive system for evaluating the risk posed by planting a particular conifer species on a given site following hardwood liquidation.

Considering the large acreages intended for annual conversion by industry and the relatively slow development of Armillariella root disease (10+ years to peak mortality), work on such a predictive system should begin immediately.

LOGGING DAMAGE INVENTORY: 1981 (J. N. Bruhn, MTU)

This inventory was conducted in cooperation with the Forest Service Forestry Sciences Laboratory in Houghton. Data are used to compare thinning systems, develop marking guidelines for operational application, and provide a baseline source of permanently located photographed wounds for subsequent study of wound healing and associated defect. Data have been collected for one study near Watersmeet. A second study was planned for 1982.

MICHIGAN IMPACT PLOT SYSTEM (MIPS): 1981 (J. A. Witter and A. M. Lynch, U of M)

The Michigan Impact Plot System was established during 1978-1979, with 136 ground sampling units to be evaluated once each year through 1984. The MIPS was established to obtain a data base for (1) testing techniques related to damage assessment, (2) quantifying the impact of the spruce budworm in the Ottawa and Hiawatha National Forests, and (3) developing a hazard rating system for spruce-fir stands in Michigan.

The hazard-rating systems will be tested and validated during 1982-1983. The system is being developed so that it can be used by field foresters as they conduct compartmental examinations of spruce-fir stands.

MYCORRHIZAE STUDY: 1981 and 1982 (J. N. Bruhn, MTU)

1981

During the Fall of 1981, red and jack pine beds at the Toumey and Wyman nurseries, and red and jack pine plantations on the Danaher Plains near Seney, were searched for fruiting of mycorrhizal basidiomycetes. *Laccaria laccata* was the only mycorrhizal species found commonly on the Danaher Plains and in the nurseries, though only on jack pine in the nurseries. A *Clitocybe* sp. was the most commonly fruiting, apparently mycorrhizal, basidiomycete under both pine species on the Danaher Plains. Technology should be investigated for nursery and greenhouse application of *L. laccata* and the *Clitocybe* sp. to improve establishment of seedlings (especially red pine) on harsh sandy sites.

Preliminary study suggests that mycorrhizal rootlets associated with the mycorrhizal fungi may be found in the absence of fruiting bodies. These relationships need further study, but may be important when evaluating the fate of specific mycorrhizal fungi subjected to different management treatments in the field.

1982

The objectives this year were to (1) flag individual nursery seedlings associated with mycorrhizal fruiting bodies to preserve their identity in the field after planting, (2) map locations of outplanted seedlings as replicated systematically within the Shingleton reforestation trials, and (3) conduct a follow-up examination of these seedlings the fall after outplanting; evaluate shoot elongation, needle length, and mycorrhizal development.

Species of mycorrhizal fungi found fruiting in the nurseries were *Thelephora terristris*, *Laccaria* sp., *Suillus* sp., and *Beloma* sp. Species found on the planting sites in the Shingleton forest were *Thelephora terristris*, *Laccaria* sp., *Clitocybe* sp., and *Cortinarius* sp. This showed that mycorrhizae exhibit a site preference. Therefore, testing the survival of different species of mycorrhizal fungi on planting sites is essential.

However, to evaluate the survival and relative contributions of different mycorrhizae to seedling survival and vigor, mycorrhizae associations often must be identified without fungal fruiting structures. The cataloging and characterizing of mycorrhizal rootlet morphology types has been started.

CCMS GYPSY MOTH SURVEY: 1981 and 1982 (T. Prokrym, MSU)

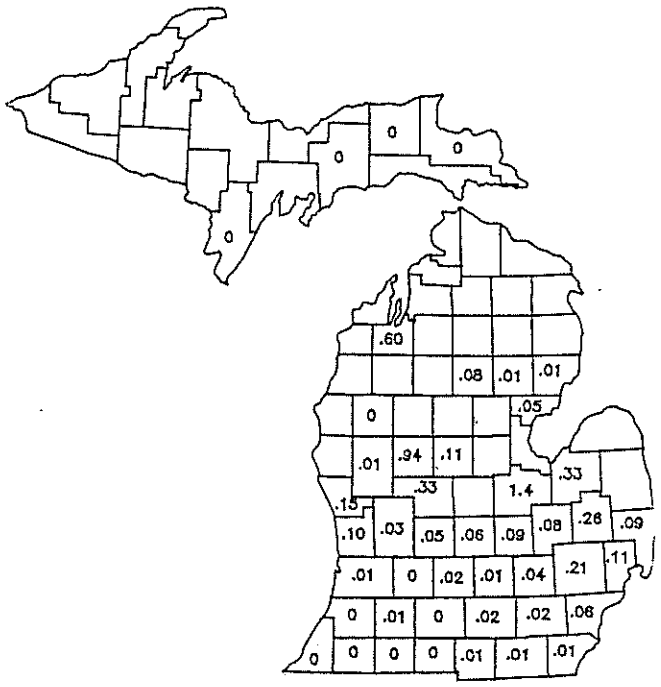
In 1981, the Cooperative Crop Monitoring System (CCMS) in conjunction with MDA and USDA/APHIS (Animal Plant Health Inspection Service) developed a computerized system for entering, processing, and storing gypsy moth pheromone trap data generated by this program. In 1982, data on 16,930 traps were processed by CCMS.

Two types of pheromone traps were used in 1981 (Delta and milk carton). In 1982, only Delta traps were used. Pheromone traps were set in 46 Michigan counties. Trap density varied with the intent or purpose of the trapping. To detect gypsy moths, traps were set at a density of 12 traps per township or one trap per three square miles. To delimit known populations, traps were set at densities of 4 to 16 per square mile. To monitor areas that had been chemically treated for gypsy moth control, traps were set at 15 to 32 per square mile.

Trap locations within selected counties were determined by MDA and USDA/APHIS. Personnel from these agencies were responsible for setting, recovering, evaluating, and recording traps and trap catch information.

Information recorded for each trap was (1) trap location: county, township, section, quadrat; (2) setout and recovery dates; (3) trap status: replaced, lost, not set due to lack of suitable hosts; and (4) number of gypsy moths captured.

The following figures are examples of the summarizations of the collected data.



Gypsy moth pheromone trapping average catch per recovered trap: 1981.

Gypsy moth pheromone trapping average catch per recovered trap: 1982.

CONTROL PROGRAMS

SARATOGA SPITTLEBUG POPULATION REDUCTION (REGION II): 1982 (F. Sapio, MSU and R. Murray, DNR)

Saratoga spittlebug populations in young pine plantations have been monitored since 1979. In June of 1982, personnel were trained to conduct nymphal surveys. The surveys, completed in three weeks, showed three plantations to have populations warranting immediate suppression (153 acres, for a total cost of $8.45 per acre). The plantations were in Wexford, Roscommon, and Gladwin counties. Population reduction is necessary when thresholds reach 2.0 nymphs per tree unit. At this level, branch flagging and growth reduction as high as 41% is possible.

Cythion, a formulation of malathion, was the pesticide sprayed. Cythion is registered for application to plantation pines and has been used successfully in many areas. Before the 153 acres of red pine were sprayed, local newspapers and radio stations were notified.

The treatment took place on July 13. A DNR spotter plane led the spray plane to appropriate locations and monitored for coverage and drift, which was minimal. Although it rained six hours after the treatment, a post-spray survey showed a low survival of adult Saratoga spittlebugs. Only 13 adults were found in all the plantations.

In 1983, untreated plantations will be monitored. Plantations with population thresholds of 2.0 nymphs per tree unit or higher will be considered for treatment. A program to reduce the alternate hosts of Saratoga spittlebug in pine plantations is planned for the fall of 1983. Eliminating sweet-fern and other alternate hosts should reduce the number of plantations requiring monitoring and treatment.

JACK PINE BUDWORM SUPPRESSION PROJECT: 1982 (R. Murray, DNR and F. Sapio, MSU)

Damage during the current jack pine budworm outbreak has been more severe than recent outbreaks. Several factors have contributed to the increased damage.

(1) Michigan has an increasingly large acreage of overmature jack pine. Stands over 50 years old are high risk, and much of the jack pine forest in northern Lower

Michigan is past the 50-year mark--some as much as 10 or 20 years past. Due to poor market conditions, land managers store jack pine on the stump, thus increasing the amount of older jack pines.

(2) Stands have not always been regenerated to an even-aged condition. The relatively low value of jack pine stumpage over the past years has discouraged added expenditure of site reparation and artificial regeneration to insure fully stocked, even-aged stands. Natural regeneration has been tried, but usually has resulted in two-aged and poorly stocked stands.

The jack pine budworm rarely attacks small trees. However, high levels of budworm have been found attacking trees eight feet tall and shorter. This has been attributed to large populations developing in high risk stands that surround stands of small trees. After the higher risk stands are fully occupied, the budworm infest the small trees.

This problem in small trees was first noted during inspections of jack pine plantations in the Roscommon area. Further investigation showed a budworm population high enough to cause top kill and tree mortality. A survey found that plantations in the northwest part of the state were not in danger, but 1,749 acres of Forest Management plantations and 2,035 acres of Kirtland's Warbler plantations had populations significant enough to warrant control.

The insecticide Sevin-4-oil was selected for aerial application. Application was handled by an independent spray contractor, using a fixed-wing agricultural spray plane (Ag-Cat) for $3.05 per acre, excluding the insecticide. Sevin was applied at one quart per acre mixed with one quart of #2 fuel oil, with winds no greater than ten miles per hour.

A DNR-owned T-34 spotter plane with a DNR pilot and an observer familiar with the areas to be sprayed guided the spray plane to plantations. The aerial applicator was given clearly marked aerial photos of each area to be treated. The estimated cost of the spotter plane was fifty cents per acre--considerably cheaper than the cost of ground operations. It also allowed better observation of drift and application than is possible from the ground.

Before the operation, local newspapers and television and radio stations were notified. Although advanced publicity was limited due to the short time interval between infestation discovery and control operation, news announcements were made on radio and television, with follow-up stories. No adverse public comment was received.

Post-spray evaluations showed larval mortality between 90 and 100%. Allegheny mound ants seemed to contribute to population reduction, especially by preying on budworm pupae.

Defoliation on non-treated areas differed significantly from treated areas, but not as much as expected. A period of cool, wet weather seemed to deter feeding during the fifth and sixth instars--the prime feeding stages.

An overwintering survey was conducted for these areas during the winter of 1982-1983. For areas with a significant overwintering population, an early larval survey will be planned, followed by a late larval survey—if the previous survey indicates a need. Such population monitoring reduces damage, because damaging population levels will be found earlier in the budworm cycle. Permanent sampling locations will be set up and regularly monitored on small tree plantations and higher risk stands. Particular attention will be given to areas where small plantations are mixed with high risk stands.

Jack pine budworm post-spray evaluation: 1982[1]

Plantation Location	Plant Mortality %	Top Kill %	No. Pupae/15 Inches Leader	No. Pupae/15 Inches Lateral	Average % Defoliation (new growth)
Management Plantations					
T32N, R1W, S3	0	0	0	0	≤ 25
T32N, R1W, S10, S11	0	0	1.00	1.10	25-30
T29N, R2E, S30	≤ 5	≤ 25	.33	.13	25-50
T29N, R2E, S31	≤ 5	≤ 5	.13	.06	≤ 25
T29N, R1E, S5	≤ 10	≤ 25	1.40	.73	25-50
T29N, R1E, S15	≤ 5	≤ 10	.20	.06	25-50
T32N, R1E, S22	≤ 10	≤ 25	.75	0	25-50
T29N, R1W, S16	≤ 5	≤ 5	0	.06	≤ 25
T31N, R5W, S18, S19	≤ 5	≤ 5	0	0	≤ 25
T27N, R8W, S22	≤ 5	≤ 10	.20	.06	≤ 25
T28N, R5W, S11, S12	≤ 5	≤ 5	0	0	≤ 25
T24N, R2W, S17	≤ 5	≤ 5	.20	.02	N/A
T24N, R2W, S22	≤ 5	≤ 5	.73	.15	25-50
T24N, R2W, S23	≤ 5	≤ 10	0	.20	N/A
T24N, R2W, S22	≤ 5	≤ 5	.26	.20	N/A
T24N, R2W, S22	≤ 5	≤ 10	0	,30	25-50
T24N, R2W, S17	≤ 5	≤ 25	0	.30	25-50
T23N, R1W, S25	≤ 5	≤ 10	.13	.20	≤ 25
T23N, R1W, S25	≤ 5	≤ 5	.26	.13	25-50
T23N, R1W, S36	≤ 5	≤ 10	.06	.13	≤ 25
T23N, R1W, S36	≤ 5	≤ 5	0	0	≤ 25
T26N, R2W, S1	≤ 5	25-30	.80	.60	≤ 25
T24N, R2E, S23	≤ 5	≤ 5	0	0	≤ 25
T24N, R2E, S4	≤ 5	≤ 5	0	0	≤ 25
Kirtland's Warbler Areas					
Odessa Road	≤ 5	≤ 5	0	0	≤ 25
Red Oak	≤ 5	≤ 5	.93	N/A	≤ 25
Farrington Road	≤ 5	≤ 5	.87	N/A	25-50
F-97	≤ 5	≤ 30	.82	N/A BF 25	50-75
Walsh Road	≤ 5	≤ 5	.88	N/A BF 25	50-75
Fletcher	≤ 5	≤ 5	0	N/A	≤ 25

[1] Back-feeding (BF) negligible on all plantings unless noted.

OAK WILT DETECTION AND CONTROL: 1982 (DNR) (R. Heyd, DNR; and E. Abel, MDA; R. Breyer, Coop. Exten. Service; J. Bruhn, MTU; and B. Lockhart, Menominee Co.)

Oak wilt was detected in the fall of 1981 in the Shakey Lakes Area, Lake Township, Menominee County. This part of Menominee County has approximately 10,600 acres of the very susceptible red oak forest type. To date, oak wilt has killed approximately 1,000 red oaks in 22 epicenters and could spread rapidly, eliminating much of the oak resource in this area.

A control program was started in 1982. The cost of the material was provided by the Lake Township Board and the County Road Commission. The control project was conducted by the County Extension Service (MSU), Menominee County Parks Service, DNR, and some landowners.

Epicenters in residential areas were treated first, then the more remote epicenters. Because new epicenters were found during the treatments and time and resources were limited, not all epicenters were treated. These will be treated in 1983, when the first treatments will be evaluated for effectiveness.

HERBICIDAL SUPPRESSION OF SWEET-FERN: 1981 and 1982 (R. Heyd and R. Murray, DNR)

A pilot study was begun in September, 1979, to determine the feasibility and cost of reducing sweet-fern to acceptable levels on moderate to high risk red and jack pine planting sites and to young plantations. As sweet-fern is an alternate host for the Saratoga spittlebug, projected benefits were increased growth and survival of red and jack pine from greater Saratoga spittlebug control and less ground cover competition.

Five locations in Northern Lower Michigan (Osceola, Wexford, Crawford, and Cheboygan counties) were selected. These locations had high densities of sweet-fern. Roundup and Krenite were applied in three concentrations in 1/50th acre plots at each location. Pre-spray data was collected in the spray plots and a control plot at each location. The plots were sprayed about one week before fall color began (September 17 to 21). The plots have been evaluated each year since 1979.

Two quarts of Roundup per acre had suppressed sweet-fern (and blueberry) to acceptable levels as of 1982. Acceptable levels are defined as low risk for Saratoga spittlebug injury and significant reductions in ground cover competition. Although these results are promising, a large-scale study is needed to determine the actual costs and benefits of sweet-fern suppression.

RED PINE RELEASE: 1982 (R. Heyd, DNR)

The herbicide Esteron 99 conc was aerially applied to a 220-acre red pine planting in the Naubinway Forest Area, Dickinson County. The herbicide killed an overstory of poor quality aspen that was restricting severely the growth of the red pine.

SITE PREPARATION FOR RED PINE: 1982 (R. Heyd, DNR)

A 40-acre site in the Gwinn Forest Area, Marquette County, was prepared for planting red pine in the spring of 1983. The site had been poorly stocked with much open area. Aspen and hardwood sprouts and other competing ground vegetation were suppressed with Roundup. The herbicide was applied with a skidder equipped with a 300-gallon tank and a boomless nozzle. The nozzle performed well. Chemical distribution and efficacy will be evaluated in the spring of 1983.

PILOT TESTS

GYPSY MOTH PARASITOID RELEASE: 1982 (R.J. Priest, MDA)

The 1982 Michigan Department of Agriculture gypsy moth management plan called for no extensive treatment in areas considered generally infested. Therefore, the introduction of parasitoids was considered.

All known egg mass areas in Clare, Gratiot, Isabella, Mecosta, and Midland counties were scouted to determine sites suitable for releasing the egg parasitoid, *Ooencyrtus*

kuvanae (Howard). Twelve sites had high pest levels and low chances for landowner treatment. Arrangements were made with Dr. Robert Fusco, Supervisor of the Biological Control Section, Pennsylvania Department of Environmental Resources, to collect parasitized egg masses. On August 31, nearly five gallons were collected in Clearfield County, Pennsylvania. They were then brought back to Michigan for field exposure.

At each release site, egg masses were divided among a series of screen-lined hardware cloth cages. Each cage was attached to a host tree with visible native egg masses. Parasitized egg masses were left in the field until early winter. This allowed two generations of *Ooencyrtus* to develop and adults to move into the leaf litter. The cages were then recovered and egg masses destroyed.

Winter survival of this parasitoid will be determined in 1983 by recovering it from native egg masses. Once established these sites will serve as reservoirs for subcolonizing other sites.

CONTARINIA NEEDLE MIDGE OF RED PINE: 1981 (N. F. Sloan, MTU)

The experimental insecticide NEEM will be tested in 1982 for efficacy of control against Contarinia needle midge on red pine plantations at the Huron Mountain Club north of Marquette. A needle midge infestation covering approximately five acres of 20-feet-tall red pine was found for the first time in 1981. This area will be monitored in 1982 in conjunction with the insecticide trial.

MYCORRHIZAE PILOT STUDY: 1981 (USFS)

This three-year pilot study, conducted by the USFS at the Toumey Nursery in Watersmeet, Michigan, was completed in May, 1981. Red pine seedlings were inoculated with *Pisolithus tinctorius* (or *P.t.*), a mycorrhizae used successfully in the southeastern forest area of the U.S. Although *P.t.* had been successfully established as far north as southern Wisconsin, it was replaced almost completely by mycorrhizae endemic to the nursery (*Thelephora terristris* and *Laccaria* sp.). The results of this pilot study prompted the need for a project to identify and evaluate mycorrhizae endemic to the U.P. The ultimate goal is to increase early growth rates and survival of out-planted seedlings and to reduce nursery fertilizer needs by providing mycorrhizae appropriate for specific areas of the U.P. for seedbed or container inoculation.

SHINGLETON REFORESTATION TRIALS: 1981 and 1982 (J. Bruhn, MTU and R. Heyd, DNR)

The Shingleton Reforestation trials is a cooperative project between the Michigan Cooperative Tree Improvement Program (MSU), the MTU, and the Forest Management Division of the DNR. The purpose is to determine the feasibility of reforesting areas within the Kingston Plains, Fox River Plains, Sucker River Plains, and Danaher Plains (approximately 50,000 acres) in the Shingleton Forest area of Michigan's Upper Peninsula. Large, white pine once grew in these areas. Clear-cutting and fire during the turn of the century, however, removed much of the pine regeneration and destroyed much of the humus so important to the productivity of these sandy soils. Since then, plantation establishment has been hindered by a lack of humus, competing vegetation, white grubs, harsh climate, scleroderris, and other factors.

The primary goal of this project is developing techniques for the successful establishment and rapid initial growth of tree species suited to these sites. Surviving trees reaching a height of 8 ft. or more seem to "take-off" and grow very well. Additionally, alternative tree species other than red and jack pine will be sought to increase species diversity and overcome host specific pest problems (i.e. scleroderris).

1981

Two sites were located for the proposed experimental plantings: one near Stanley Lake on the Fox River Plains and one on the Danaher Plains. Each site will receive two separate planting trials in the spring of 1982.

The first trial will evaluate the influence of combinations of herbicide-no herbicide and furrowing-no furrowing treatments on the growth and survival of red and jack pine. Additionally, seedlings associated with known mycorrhizal mushrooms in nursery beds will be planted to evaluate seedling and fungi performance.

The second trial will be a species trial. Herbicide will be used to control vegetative competition without furrowing. Red and jack pine will be planted as containerized and bare root seedlings. Other species to be planted include hybrid pine *(P. nigra x P. densiflora)*, Japanese larch *(Larix Leptolepsis)* and European larch *(L. decidua)*.

Roundup (glyphosate: Monsanto Chemical Co.) at 2 quarts per acre was applied in Augustin preparation for next year's planting trials.

1982

All trials were planted in May, 1982. A 5% granular formulation of Amaze (Isophenphos: Mobay Chemical Company) was used in all areas to test its effectiveness in controlling white grubs.

Results of these trials will be evaluated in June 1983. Additional planting trials will be undertaken in 1983. New tree species, a new liquid formulation of siophenphos for white grub control, lichen suppression, and further mycorrhizal trials will be added to the project.

BIOLOGICAL SUPPRESSION OF THE SPRUCE BUDWORM: 1982 (R. Heyd, DNR)

One thousand acres in the Gwinn Forest Area were sprayed aerially in the spring of 1982 with a new high potency formulation of *B.t.* The purpose was to evaluate the efficacy of the formulation against the spruce budworm. The USFS, Methods and Application Group, cooperated with the Michigan Cooperative Forest Pest Management Program on the project, which was funded by the CANUSA Spruce Budworm Project. Results of the project will be available in 1983.

WHITE GRUB SUPPRESSION: 1982 (R. Heyd, DNR)

Isophenphos, an insecticide manfactured by the Mobay Chemical Company as Amaze and Oftanol, was pilot tested for white grub suppression in conjunction with the Shingleton reforestation trials and a red pine planting in the Gwinn Forest Area. Amaze 5% granules were applied in 12" strips over the seedlings at two pounds per acre.

Results will be collected in 1983. Preliminary observations showed some grub suppression. However, the granules need rainfall to move the isophenphos into the root zone. Heat and light reduce the potency of isophenphos. As the spring of 1982 was dry, the potency of the isophenphos may have decreased. A liquid formulation may be available for testing in 1983.

RESEARCH REPORTS

SPRUCE BUDWORM TECHNOLOGY TRANSFER: 1981 (G. A. Simmons, MSU and J. A. Witter, MSU and U of M)

The major objectives of the technology transfer program are (1) to establish linkage between scientists and users, (2) to design and implement an educational program, (3) to use feedback in planning, implementing, evaluating, and modifying the program, and (4) to develop specific products (how-to's, technical bulletins, workshops, etc.). This project has concentrated on assessment need surveys of pest management specialists and foresters, developing a technical manual on the spruce budworm, writing a "how-to" on chemical control, and presenting a workshop using 35 mm photography to assess damage.

RESEARCH AT THE UNIVERSITY OF MICHIGAN: 1981 (H. L. Morton, U of M)

Research was being conducted on (1) growth impact and tree mortality of Diplodia twig blight on Austrian pine, (2) biology and control of Phomopsis canker on Russian-olive, (3) formation of the sexual stage of the Dutch Elm disease fungus in insect galleries, (4) the effect of Fomes annosus on the growth and yield of red and white pine, and (5) fungicidal control of Christmas tree diseases.

PESTS OF HYBRID POPLAR: 1981 AND 1982 (L. F. Wilson and L. M. Moore, USFS)

1981

Poplar-gall saperda *(Saperda inornata)* continued to attack hybrid cottonwoods

planted in 1979, though more galls were confined to lateral branches in 1981 than the previous years because of increase in stem diameter. Stem galls accounted for 98, 85, and 37% of all galls in the three years, respectively. Galls on stems are important because the tree can break over, though less than 10% of the stems have broken over so far. Other than a small amount of mortality (7%) in the first year, growth loss from gall formation was insignificant.

The spotted poplar aphid *(Aphis maculatae)* was found in large colonies in hybrid cottonwood nurseries and stands. Single-spray tests using fatty-acid insecticides (insecticidal soaps) reduced populations from 77 to 96% in a 12-hour period. These soaps literally "dissolved" the insects. Death was quick. The insecticide must contact the insect to be effective.

1982

Research was continued on pests affecting intensively grown hybrid poplar. The study areas were on lands owned by Packaging Corporation of America (PCA) near Manistee, MI. The major pests observed were (1) Septoria *(Septoria musvia)*. (2) Poplar-and-willow borer *(Crytorrhynchus lapathi)*. (3) Poplar-gall saperda *(Saperda inornata)*, (4) Marssonina *(Marssonina brunnea)*. (5) Spotted-poplar aphid *(Aphis maculatae)*. and (6) Melampsora leaf rust *(Melampsora medusae)*. Some minor pests observed were willow shoot sawfly *(Janus abbreviatus)*, cottonwood twig borer *(Gypsonoma haimbachiana)*, and "black stem" *(Cytospora, Phomopsis,* and *Dothichiza)*.

Septoria canker, caused by *S. Musvia* fungus, is currently the most important pest of intensive cultured hybrid poplar. This fungus attacks trees of all ages and sizes, but is most severe on trees in young plantations, nursery stock beds, and coppice plantations. Heavy infections cause tree deformities, stem breakage, and tree mortality.

The poplar-and-willow borer, a snout weevil, is the most important insect of hybrid poplar. This insect attacks trees that are 1 to 4 inches in diameter. As tree diameter increases, they move up the tree. The larva bores into the center "pith" of the tree causing stem breakage and tree mortality during heavy attacks.

Currently, pest organisms have little impact on intensive cultured hybrid poplar.

SPRUCE BUDWORM RESISTANT WHITE SPRUCE: 1982 (R. Heyd, DNR)

The Michigan Cooperative Tree Improvement Program (MICHCOTIP) collected seed and cuttings from a white spruce displaying resistance to spruce budworm defoliation. The tree was identified by a DNR forester in the Naubinway Forest Area as part of MICHCOTIP's Sweet Tree Program (MICHCOTIP offers a half gallon of maple syrup to people identifying and locating trees judged "superior.")

Evolving resistant white spruce is an important step in developing a lower risk spruce-fir resource.

RED PINE CONE BEETLE STUDY: 1982 (W. Mattson and J. R. Miller, MSU)

The red pine cone beetle *(Conophthorous resinosae)* is a pest that kills pine cones, thereby preventing seed growth and decreasing the amount of seeds to regenerate a forest. Researchers are studying the cone-finding behavior of the red cone beetle to learn the plant cues to which the beetle responds. This information will be used to develop management strategies for the beetle. Future research will include a comparative study of red and white pine.

RESISTANCE OF WHITE SPRUCE AND BALSAM FIR: 1982 (W. Mattson, MSU)

This project is investigating resistance of white spruce and balsam fir to the spruce budworm *(Choristoneura fumiferana)*. Specifically, how plant terpines and nitrogen affect the growth and fecundity of spruce budworm larvae are being studied. The study has found that when foliar nitrogen is increased, spruce budworm larvae grow faster and larger and become more fecund than those reared without increased nitrogen. Increased terpines, however, specifically camphine and camphor, reduce growth and increase larvae mortality.

This study will be expanded to provenance plantations in the Kellogg Biological Station and elsewhere in the Lake States.

SPRUCE BUDWORM PARASITOID ACTIVITY (J.P. Nyrop and G.A. Simmons, MSU)

A study was conducted on the spatial and temporal dynamics of the adult parasitoid *Glypta fumiferanae*, which attacks first and second instar spruce budworm. The findings showed that (1) the searching efficiency of *G. fumiferanae* is reduced in wet and cold weather, (2) habitat does not influence the parasitoid's ability to obtain nutrients and moisture, and (3) the spatial distribution of the adult female parasitoid within a tree crown is influenced by temperature and light. These factors affect the ability of the parasitoid to act as a biological control agent.

FOREST HARVESTING AND THE SPRUCE BUDWORM (J.P. Nyrop and G.A. Simmons, MSU)

A project was begun in 1979 to examine how the problem of spruce budworm, mature forests, and the demand for wood could be addressed by partially harvesting existing stands. The theory was to create openings in a forest that would encourage natural enemies and therefore increase spruce budworm mortality. Previous studies and computer simulations seemed to point to this technique working; however, it did not work when tested in the field during an outbreak. To get a more complete understanding of this strategy, data needs to be collected for a number of years. Despite the failure, the strategy has potential for helping forest managers deal with the spruce budworm.

BRONZE BIRCH BORER ON ORNAMENTAL WHITE BIRCH (J.J. Ball and G.A. Simmons, MSU)

This study found that by using a shigometer, ornamental white birch trees could be identified if they were of high risk to bronze birch borer damage before symptoms became visible.

EGG MASS SAMPLING (G.W. Fowler, U of M and G.A. Simmons, MSU)

Procedures were developed for sampling egg masses to predict spruce budworm populations and potential damage to spruce and fir trees. The procedure includes regional monitoring for managing and evaluating units and stands. A parallel project has begun for the jack pine budworm.

SCREENING ASPEN FOR RESISTANCE TO HYPOXYLON CANKER: 1982 (J. Hart, MSU)

To determine the effect of environment and genotype on disease development, two ponderosa pine provenance plantings were infested with Western gall rust. Preliminary analysis indicated that environment impacted disease development more than genotype. Mammotoxin, a host-selective toxin from *Hypoxylon mammatum*, was purified using HPLC. Research is continuing to determine more specific correlations among environment, genotype, and the disease.

DISEASE PROBLEMS OF WOODY PLANTS (J. Hart, MSU)

Studies conducted on black walnut trees from eight states (Illinois, Indiana, Kansas, Kentucky, Michigan, Mississippi, Pennsylvania, and Wisconsin) showed that sapwood was more susceptible to decay than heartwood. Radial or longitudinal position does not significantly change decay resistance in heartwood. Genetic variability, however, gives trees from the same state significant variations in decay resistance.

Similarities found in heartwood decay resistance suggest that site is not important when determining decay resistance. Sapwood to heartwood ratios also were not indicators of heartwood decay resistance.

The amount of decay, value lost due to decay, and the possible cause of decay was determined for 29 black walnut stands as they were harvested. Of 808 total trees, 153 contained enough decay to lower their value. Total volume was 113,646 b.f. (5% was lost to decay). Total value was $75,000 (11% was lost to decay). The most frequent probable cause of decay was a prior history of livestock in the stand.